

# CHEMICAL METALLURGICAL ENGINEERING

CHEMICAL & MET.  
ENGINEER

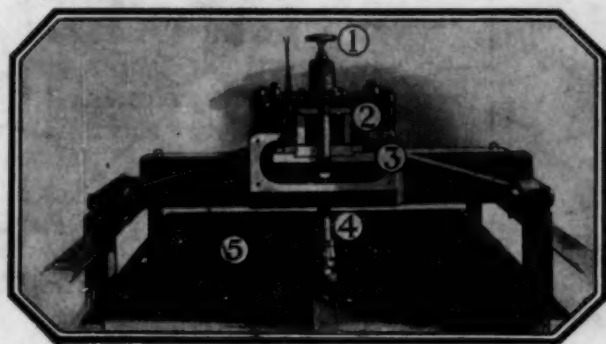
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August 3, 1921

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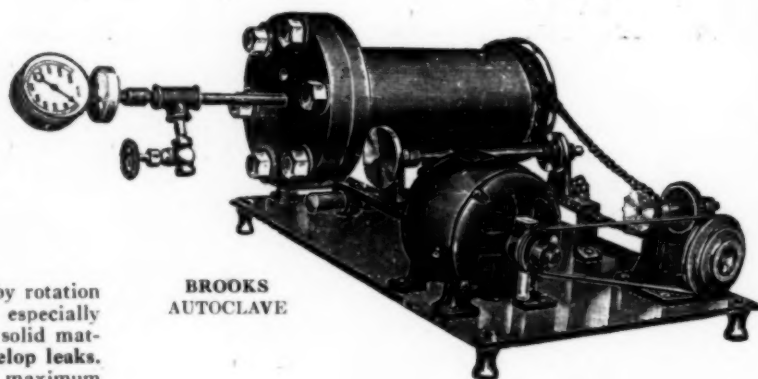
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# CHEMICAL & METALLURGICAL ENGINEERING

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Number 5

## A Leaf Out Of the Past

THE London *Times* lately told a few things about the Royal Institution of Great Britain which are worth remembering—and worth pondering over as well. It was founded by a few Fellows of the Royal Society in 1799 of whom Count RUMFORD provided the initial funds. Its purpose was to "diffuse knowledge of useful mechanical improvements" and to "teach the application of science to the useful purposes of life." It was to be popular and practical enough to satisfy anybody. But its administrators soon discovered that the only way to be practical in things scientific is to engage in research. The reason should be patent to everyone, although unfortunately it is not. Science is not static; it does not stand still; it is dynamic; it is pressing forward and according to Dr. SARTON it presses forward in the ratio of human development. The history of science he says is the history of human progress and he gives a galaxy of evidence to prove his thesis. If then we are to "diffuse" or "teach" this moving thing we cannot stand still ourselves. If we do, it will move away from us. Our only method therefore is to get aboard the research van and to move along with it. Otherwise we shall teach something that has gone on and left us behind.

On the other hand, if we merely set somebody to work in a laboratory and call it the prosecution of research we are not of necessity accomplishing anything. We are doomed to failure unless we have wisdom—and use it. The Governors of the Royal Institution proved themselves to be of the elect in this respect. By July, 1801, they had established THOMAS YOUNG as the first resident professor, who as the *Times* puts it, "was the father of all our knowledge of color vision and of the properties of the lens of the human eye, the discoverer of 'interference' and the first to define 'energy'." The statement may be a little broad, but let's pass it on without discussion. The same year they engaged HUMPHRY DAVY at a salary of 100 pounds a year, a room, coal and candles. In return for this he gave popular lectures which became the talk of London, and his contributions have become classic. He was succeeded by MICHAEL FARADAY, whose name is writ high in the heavens of science, and the present resident professor is Sir JAMES DEWAR. The mere mention of these names conjures up the living soul of science today.

The only recorded static aid to the Royal Institution was a Civil List pension of £300 annually to FARADAY for a few years. The whole cost of the Royal Institution during the entire nineteenth century, including professors, attendants, the maintenance of laboratories and the purchase of apparatus and materials, was \$100,620, or a little over £1,000 a year. Gifts and

donations have been few; the revenue to support the institution has been almost wholly derived from admission fees paid by the public to hear the lectures.

What a record this is! No begging, no pulling and stripping of the legs of millionaires, nobody getting personally rich out of it and nobody made poor, and yet what a benefit to all humanity! FARADAY was so interested in his work that he refused a fortune for himself in order to provide wealth and happiness for generations then unborn. Sometimes it seems as though in some respects we hadn't kept up with those memories of grace that came over from the eighteenth century, lasted into the nineteenth for a while, and then, somehow, went into eclipse.

## Prohibition and Industrial Alcohol

WEBSTER defines a fanatic as "a person affected by excessive enthusiasm; one who indulges in wild and extravagant notions; a visionary zealot." A zealot, according to the same authority, is "one who engages warmly in any cause and pursues his subject with earnestness and ardor." Can it be possible that with rare prescience Mr. WEBSTER was giving us a character delineation of Mr. VOLSTEAD? We infer as much from comments in the daily press and from the laws for prohibition enforcement proposed by the honorable Congressman.

The exact wording of the Eighteenth Amendment escapes us for the moment, but we are under the impression that it prohibits the manufacture and sale of alcoholic liquor for *beverage* purposes. No mention is made of industrial or medicinal purposes, and as far as we are aware there was no intention to affect those legitimate uses of alcohol. It is not surprising, therefore, that in the recent debate on Mr. VOLSTEAD's supplementary bill for prohibition enforcement several Senators reminded their colleagues that industrial and medicinal uses of alcohol are outside the pale of the Eighteenth Amendment; that there is a large and legitimate industrial alcohol industry quite apart from the business that is prohibited. In support of this contention it is worth noting that the failure of the British Government to give its dye industry duty-free alcohol is ascribed by the *Chemical Age*, London, as one of the two major causes contributing to the failure of the early efforts to establish a dye industry in England. Germany, on the other hand, recognizing the importance of industrial alcohol, fostered the industry by removing restrictions and handicaps and otherwise built up the greatest coal-tar industry the world has ever seen. If Mr. VOLSTEAD can become less obsessed with the iniquity of "booze" and more impressed with the essential and legitimate uses of alcohol, numerous and varied industries will breathe more freely.

### Business Revival And Our Export Trade

**I**N THESE days when foreign trade and the tariff figure so prominently in our schemes for business revival, it is perhaps time to take an inventory and pass judgment on the relative importance of these factors. Foreign trade has been emphasized to such an extent of late that we are apt to lose sight of the fact that even in the balmiest years when exports were at their peak, they amounted to less than eight per cent of the total sales of the country. We often fail to realize that over ninety per cent of business as a whole was done in the domestic market.

The resumption of exports must depend, to a large extent, upon the foreign buyer's ability to pay us for our goods. If the restoration of normal business in this country, however, is to await the financial rehabilitation of Europe, then our return to prosperity promises to be a slow and difficult process. It is best that our efforts at business revival be diverted toward the home market, wherein lies the greater opportunity.

The Government can assist in this process mainly by the enactment of proper tariff and taxation measures. It is extremely difficult for the layman to see how the tariff is going to restrict imports and at the same time build up our export trade. We have hopes, however, that the new law will be so framed that the home market will be reserved for the domestic manufacturer, but that this will be accomplished without prohibiting fair competition from abroad. Europe must pay her obligations in goods, but obviously those goods must be such as to affect least seriously our own industries. Taxation enters into our calculations somewhat less directly, for taxes are seldom so oppressive as to have material effect on our purchasing power. It is generally admitted, on the other hand, that the present distribution of taxes has retarded rather than encouraged the investment of capital in necessary building and development.

Industry's chief contribution to the reviving process consists in the adjustment to lower prices by means of higher efficiency and hard work. This adjustment is inevitable and the American manufacturer must meet the situation with lower costs, which in turn mean increased efficiency.

Industry is affected in some degree by our exports and for that reason the export problem can not be dismissed completely from our consideration. In the case of many commodities, this trade, although of small volume, has an entirely disproportionate significance. A normal outflow will continue for those products for which our natural resources or our own ingenuity have placed us in a position of comparative advantage. Copper, iron and steel, cotton, meat and farm products are natural exports. We are also peculiarly adapted to export fabricated articles of large-scale production and standardized manufacture. Our foreign trade in dyes is an example of this natural development. The well-standardized articles of quantity output, such as indigo and sulphur black, are produced in excess of our requirements and are exported in large quantities. On the other hand there are many special products of secondary importance from a quantitative viewpoint which our industry is not yet producing in adequate amounts to supply even the domestic consumption.

A foreign outlet for some other products of our chemical industry is desirable and essential, but it is to be admitted that much of our war-time trade was

unnatural and its continuation can not be expected. Artificial stimulation by foreign financing and the exporting of goods on long-time credits have been proposed, but in our estimation they represent only a means of continuing our abnormal exports. Our foreign trade must be put on a safe and logical basis, but in the meantime we should not forget that our most direct path to business revival lies at our very door.

### News Value or Nuisance Value?

**O**N THE HOTTEST day yet there came to us a "news note" from a well-known corporation that shall be nameless because it ought to know better. Probably the Old Man does know better but is away on his vacation. The item reads as follows: "Blank Co. Distributes New Blotter. The Blank Co. are placing in the hands of their representatives for distribution a new and attractive blotter. The Blank Co. have always been strong advocates of the blotter for advertising purposes because of its usefulness, its attention value and its ability to drive home its sales message."

This is the kind of information for which our readers are supposed to hunger and thirst; to pay good money for subscriptions so that they may read it and still more good money to have their advertisement accompany it. It pains us to have anybody think so. We have a high opinion of our readers; a sense of brotherhood with them. We talk out of our hearts to them and feel that they understand, and in return they often talk straight from their hearts to us and we think we understand. We don't set up to be professional high-brows (who are those, according to Brander Matthews, whose instruction exceeds their mental capacity), but at the same time we do not worry over reducing the expression of our opinions to words of one syllable. We do not worry over the adenoids of our readers; we take it for granted that if they ever were congested they were duly removed; and we do not try to reach the feeble minded or those who are defective.

On the other hand we want news; all the news that is really news and that is worth reading and fit to print. Had the company in question developed a new product or process, different from any that is known and of such value that in our judgment our readers would be glad to know of it, we should have been glad to publish a technical article on the subject. We are not influenced by the advertising value such an article may have to the concern that produces the apparatus or product. If we think it worth while we print it, whereas if we do not think it worth while there isn't any money that can get it printed except at advertising rates and as an advertisement in the advertising section.

We do not print advertisements either as so-called "reading matter"—to fool our readers, or interspersed with it—to disturb them. Advertising is a legitimate art but it has been made the subject of serious malpractice. One of the most serious phases of this malpractice is to give it nuisance value. It consists in stealing the attention of busy men to tell them something they do not want to know. It has not a tithe of the value ascribed to it. Men with things to do and with obligations to perform are beginning to realize this. If we do not chew tobacco we do not want to be told which preparation of tobacco to chew. When we read our morning newspaper and are trying to learn what is being done with the tariff bill in Washington, we do not want to be interrupted by the information



that the Maison de Paris is having a grand marked-down sale of lingerie. On the other hand, the women of the household may want to know about the sale but may not be interested in the tariff bill. This misplacement of news and advertising is a mistake, so far as we are concerned.

Worse than such a mix-up of understanding and underwear is the publication of news of such inane items as that a corporation has bought some blotting paper and had its name printed on it. That brings the corporation's name before our readers, but it offends them, and rightly so. It does not interest us and we don't see how it can interest anybody else.

### The Steel Corporation's Quarterly Report

THE United States Steel Corporation reports \$21,892,016 as its "net earnings" in the second quarter of this year, against \$32,286,722 in the first quarter and averages of \$44,000,000 per quarter in 1920, \$83,000,000 per quarter in 1916, its best year, and \$18,000,000 per quarter in 1914, its poorest year.

Wall Street found the earnings reported for the quarter just ended higher than expected and considered them very favorable in the circumstances. Wall Street looks upon these matters from the viewpoint of returns and prospects of returns on the stock outstanding.

From the manufacturing viewpoint the angle is different. Such a thing as a direct loss from operation, or lack of operation, is conceivable. Wall Street regards "net earnings" as a positive quantity, the only question being how much they will be above zero. They could be below zero, however, the amount of money expended or the obligations incurred exceeding the amount of money received for goods or services furnished. If the Steel Corporation had not turned a wheel during the quarter the expenses would have amounted to something like \$15,000,000 or more—the "net earnings" would have been that amount below zero. This total would have been made up of taxes, rents, salaries, subsidiary company bond interest and a number of other items. Interest and sinking funds on bonds of the Steel Corporation itself, depreciation charges, etc., are met out of "net earnings."

The Steel Corporation plants were not wholly idle in the quarter, but they operated at an average of only between 35 and 40 per cent. Often a manufacturing business finds it impossible to pay expenses with a 50 per cent operation, and thus the Steel Corporation did well to have any "net earnings" at all.

The showing of the Steel Corporation is made more favorable still by another consideration, that there was a decidedly broad distribution of work among its various plants. A few small plants were closed, but by far the major portion of the productive capacity was kept in partial operation, instead of work being concentrated at a few plants. That is quite different from the policy contemplated in the great period of industrial consolidation 20 to 25 years ago. An argument of which the promoters of many consolidations were proud was that in times of stress some plants could be closed and others operated in full, while no particular secret was made of the thought that when it came time to resume work at idle plants they could be started with substantial wage reductions. This distribution of work, prompted by a desire to take care of employees as far as possible, and other influences, swelled the corporation's costs per ton in the quarter just ended far above

what they would have been with a reasonably full operation although with other conditions, such as wage rates, the same.

Conditions in the present quarter are more unfavorable than conditions in the June quarter. An average operating rate of between 35 and 40 per cent in the June quarter is followed by a rate of not over about 25 per cent at the beginning of the present quarter, and sufficient increase to strike the same quarterly average is improbable. Steel prices are already about \$6 per net ton below the average price at which shipments in the June quarter were invoiced, and the trend is still downward. At the middle of the June quarter, however, there was a wage reduction, and another, to the level now common among the independent steel producers, may occur before the end of the present quarter. A part of the Steel Corporation's earnings, of course, is derived from railroad operation and the production of cement and some other materials outside of steel.

### Better Business Methods Needed

WHOLESOME advice and plain talk in palatable form characterized the address of President CHARLES H. MACDOWELL, at the recent convention of the National Fertilizer Association. Presumably his words have already reached to the uttermost parts of the fertilizer industry, but his speech could well be pondered by chemical industries other than the one to which he addressed himself. We surmise, for example, that fertilizer manufacturers are not the only ones who are ignorant of manufacturing costs or guilty of basing prices on incorrect estimates. The pitfalls left unguarded through inadequate cost-accounting are more numerous than obvious. Improvements in technology frequently find their mainspring in the cost sheet, while prudent business economy demands a thorough knowledge of those hidden and less obvious elements in cost which appear only at long intervals. Mr. MACDOWELL therefore properly took the fertilizer industry to task for ignorance of its actual costs and for the waste and inefficiency arising from lack of that knowledge.

Leadership along sound constructive lines, and not blind acquiescence to custom was another element of Mr. MACDOWELL's address. He deprecated the custom of supplying the farmer with "what he wants" in way of fertilizer instead of pointing the way to the most economical use of the most efficient fertilizers, educating the consumer to purchase on the basis of plant food units rather than cost per ton. The practice of manufacturing many brands and grades was also shown to be an important factor in increasing manufacturing costs. That it serves no useful purpose to either producer or consumer is indicated in the fact that Mr. MACDOWELL spoke of it as "all of this nonsense," and urged "a drastic elimination of brands and formulæ."

Methods of organization, relation of the parts of an organization to each other and the whole, co-ordination between sales and production managers, industrial statistics and freight rates all came in for a share of attention from Mr. MACDOWELL. In fact his speech was a wholesome industrial sermon applicable to a wider audience than he addressed in person. It has peculiar force for the entire chemical industry, however, because the production of fertilizers is a heavy chemical industry; and high grade technology, good business methods, and close chemical control are common factors in the success of all such processes.

## Readers' Views and Comments

### Setting a Recording Pyrometer for Cold Junction Temperature

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—Relative to Kirtland Marsh's article in the June 29 issue of CHEM. & MET. entitled "Setting a Recording Pyrometer for Cold Junction Temperature," I wish to correct the impression that the method of "setting" a pyrometer as set forth is applicable to all pyrometers of the millivoltmeter type.

It is true that the great majority of pyrometers in use today are those calibrated for, and using, base metal thermocouples. In this type of thermocouple the e.m.f.-temperature relation is approximately linear and a unit of temperature at any point on the scale will correspond to a like unit at the instrument "zero" or calibrated cold end temperature. Undoubtedly Mr. Marsh refers to this type of pyrometer in his article.

However, there are not a few rare metal thermocouples in use at the present time, particularly in conjunction with high-speed furnaces, ceramic kilns and heat-treating work where a somewhat high degree of accuracy is desired. The emf.-temperature relation of the platinum-platinum rhodium couple of either the Heraeus or Johnson, Matthey type is anything but linear. As a matter of fact, to obtain anything like consistent results, two separate formulas must be computed when calibrating this couple over its range, 32 to 3,000 deg. F.

The formula for the correction of cold junction temperatures varying from the calibrated cold junction temperature, of the Le Chatelier (Pt-Pt Rh) couple is expressed as follows:

$$E = (t_1 - t_0)x \text{ where}$$

$E$  = actual error in deg. F.;

$t_1$  = cold end temperature;

$t_0$  = calibrated cold end temperature;

$x$  = 0.7 for range 32 to 500 deg. F.;

0.6 for range 500 to 1,000 deg. F.;

0.5 for range 1,000 to 2,000 deg. F.

0.4 for range 2,000 to 3,000 deg. F.

It will be seen by this that any adjustment made at the instrument zero, using Mr. Marsh's method, would be a fraction of what it should be, provided the pointer is actually moved the number of degrees on the scale representing the difference between the actual cold junction temperature and the calibrated cold junction temperature.

For example, if a pyrometer is operating at 1,500 deg. F., calibrated for a cold end temperature of 32 deg. F. and having an actual cold end temperature of 75 deg. F., the error involved will be approximately 20 deg. F. at 1,500 deg. and 30 deg. F. at 32 deg. F. Naturally, as the instrument is being used at 1,500 deg. F., we are directly interested in errors that occur at that point. Therefore to adjust the instrument to read correctly we make a 30-deg. correction with the couple disconnected or a 20-deg. correction at 1,500 deg. F. The pointer actually travels the same distance in either case.

Ten degrees may not seem to be much to bother about in an industrial pyrometer installation, but there are so many other sources of error inherent in the millivoltmeter type of pyrometer that it does not seem advisable to overlook a simple adjustment of this kind.

Remington Arms Co., Inc.,  
Bridgeport, Conn.

L. W. HOPKINS.

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—Referring to the communication of L. W. Hopkins in which he criticizes the method of setting for cold junction temperature as outlined in the article entitled "Setting a Recording Pyrometer for Cold Junction Temperature" which appeared in the June 29 issue of CHEMICAL & METALLURGICAL ENGINEERING.

Mr. Hopkins' conclusions are quite erroneous and I am afraid that if he has followed out his theories in practice his temperature measurements with rare metal thermocouples have not been as accurate as he believes them to be.

Mr. Hopkins' formula for the correction of cold junction temperature gives the amount, to only a moderate degree of accuracy, which should be added to the reading of a pyrometer calibrated for a platinum — platinum + 10 per cent rhodium thermocouple when the zero setting of the instrument agrees with the calibration cold junction temperature while the actual cold junction temperature is higher or lower.

If the zero setting of the instrument is to be adjusted to correct for the cold junction temperature, the pointer should be set to the actual cold junction temperature instead of being advanced or set back an amount as determined by Mr. Hopkins' formula.

The following references discuss this subject and will substantiate this statement:

(1) The Measurement of High Temperatures, Burgess and Le Chatelier, third edition, 1912, p. 156, part 3.

(2) Supplement to Bulletin 153, September, 1919, American Institute of Mining and Metallurgical Engineers, article by Foote, Harrison and Fairchild, p. 2653, part 5.

(3) Scientific Paper 202, Bureau of Standards, p. 565, part 2.

It is evident therefore that the method of making this setting is applicable to pyrometers calibrated for rare metal couples as well as for base metal couples. I believe the only theoretical error in this method lies in the fact that since the temperature-emf. relation for rare metal couples is not linear the scale graduations on a pyrometer calibrated for these couples are not uniform. Therefore the amount of the deflection from the lowest scale division when the pointer is 20 deg. above that point will not be the same as when the pointer is 20 deg. below that point, but the difference will be so small the error involved in considering them equal, as is necessary in using the method of setting outlined in the above-mentioned article, is only a small fraction of the experimental error of making the setting.

KIRTLAND MARSH.

Aluminum Co. of America,  
New Kensington, Pa.



### Refining Chinese Bismuth Concentrates

To the Editor of Chemical & Metallurgical Engineering

SIR:—In "Refining Chinese Bismuth Concentrates," by Elton R. Darling (your issue of June 22) Mr. Darling explains that the hydrochloric solution containing the bismuth and antimony is treated with metallic iron and the metals precipitated; after thorough washing the precipitate is dried, and the bismuth obtained as a hydrate. This statement is open to question, as the addition of metallic iron liberates hydrogen, which in turn reduces metallic bismuth, and metallic bismuth is not converted to bismuth hydrate by simple drying, nor is it soluble in hydrochloric acid solution.

This would necessitate a different method of handling the bismuth and antimony metalics.

GEORGE DIEHLMAN.

New York City. Chief Chemist, Williams Harvey Corporation.

To the Editor of Chemical & Metallurgical Engineering

SIR:—May I say in reply to Mr. Diehlman that the process described is being used on a commercial scale with good results. As it works so well, it will not necessitate a different method of handling the bismuth and antimony metalics.

If my statement is wrong, perhaps he can account for the good results obtained in another way.

The James Milliken University,  
Decatur, Ill.

ELTON R. DARLING.

### Recovery of Volatile Solvents by Bregeat Process

To the Editor of Chemical & Metallurgical Engineering

SIR:—We are glad to see that our article entitled "Recovery of Volatile Solvents by the Bregeat Process" (published in CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, p. 916, May 25, 1921) has been of sufficient interest to bring forth the comments by J. C. Lawrence of Blair, Campbell & McLean, Ltd., Glasgow, Scotland—the American offshoot of which Mr. Lawrence states is the American Chemical and Sugar Machinery Company—as published on p. 93 of your July 20, 1921 issue.

With regard to this history of solvent recovery in England as described by Mr. Lawrence, it is noted that he fails to give the names and fails to state the locations of the English solvent recovery plants to which he refers. Such being the case, we cannot reply or make specific statements in regard to these plants of which Mr. Lawrence claims knowledge. The writers believe that they are familiar with all plants—of any importance at least—where solvent recovery has been attempted either in England, on the Continent or in America. We believe that each and every statement in the article, and particularly those referred to by Mr. Lawrence, are correct. The writers regret that Mr. Lawrence has not been more specific.

Concerning our summary, which Mr. Lawrence states seems to him to "require considerable modification," we believe that up to the time Bregeat started his work no company put its whole energy into the one field of solvent recovery and that the statement made, which Mr. Lawrence misquoted, and which should read as follows, is correct. "Until the Bregeat Process had been developed solvent recovery was not an industry by itself. The Bregeat Process is responsible for bringing solvent recovery out of the class of an incidental and casual art into that of an independent and well-established business."

The writers believe, in turn, that Mr. Lawrence's statement in his last paragraph to the effect that "Both

British and American firms . . . have been building and installing solvent recovery equipment of the highest type for several years" needs decided modification. That the recovery systems attempted prior to Bregeat were not of the highest type is proved by the fact that they made little or no impression on the commercial world. In many instances they were replaced or are supplemented by Bregeat plants.

M. ROULLEUX.

ROBERT G. DORT.

### The Slip Interference Theory of the Hardening of Metals

To the Editor of Chemical & Metallurgical Engineering

SIR:—The paper in your June 15 issue by Jeffries and Archer on "The Slip Interference Theory of the Hardening of Metals" will doubtless, as you suggest editorially, produce considerable discussion. My reaction on reading it the first time was one of amazement that a problem which has thus far baffled metallurgists could have such a reasonable and simple solution. Careful consideration by many minds may modify certain details, but I believe the main argument, based as it is on several generally accepted theories, will be widely accepted.

The theory, which seems to be well nigh flawless when applied to most metals and alloys, is more vulnerable when applied to steel. Perhaps carbon exists as such and cementite forms simultaneously with its separation, though I still doubt it. Perhaps the much discussed beta iron must be abandoned by its friends and supporters, though this is still an open question. Are either of the above points essential to a maintenance of the theory? They may at first thought seem to strengthen it, but it seems to me that the theory will still apply and much controversy be avoided if the points in question be made a side issue.

The internal strains set up in steel on quenching undoubtedly produce hardening in ways directly in line with the theory. These strains have often been referred to, but if a direct measurement of them has ever been made it has not come to my attention. An indirect illustration may be of some interest. A cylinder of 0.70 C steel 6 x 6 in. was quenched from 900 deg. C. in tap water. A thermocouple had been placed in a 3-in. hole at the center to study the rate of cooling. The quenching strains split the cylinder and it was found that the protection tube of the thermocouple was crushed and the diameter of the hole in the steel reduced to one-half its original size at the center of the specimen. A force to do this must be of very great magnitude, and it is not surprising if grain growth is prevented and slip produced, which will account for the hardening regardless of whether beta iron or carbon atoms are present.

CARLE R. HAYWARD.

Massachusetts Institute of Technology,  
Cambridge, Mass.

### Educational Motion Picture on Abrasive Industry

The completion of a new educational motion picture illustrative of the mineral industry is announced by the Bureau of Mines. The "Story of Abrasives" shows the generation of hydro-electric power at Niagara Falls, its utilization for the production of carborundum and aloxite, and finally the numerous interesting applications of abrasives.

## The Use of Oil in Cleaning Coal

Coal, Pulverized by Wet Grinding, Is Agitated with About 30 per Cent of Oil, Causing the Formation of an Amalgam of Clean Coal and Oil and Separation of a Refuse Practically Free From Combustible Matter

BY G. ST. J. PERROTT\* AND S. P. KINNEY†

### Foreword

By O. P. HOOD‡

**D**URING the war certain suggestions concerning power production were made by Walter E. Trent to the War Inventions Board, and at the request of the War Department facilities for experimental work were provided on the grounds of the Bureau of Standards.

The experiments were along the line of controlling the conditions of combustion in a closed space. In order to reduce slag troubles, experiments were carried out for removing ash from powdered coal. After the war, work along this line was continued, resulting in the Trent process, which agitates or beats together powdered coal, water and oil.

A new technology had previously been given to ore preparation by the use of small quantities of oil in water with froth flotation, and although the methods, results and mixtures of the Trent process were quite different, yet the same physical phenomenon of differential wetting was used, and the possibility of there being interesting results in fuel technology was evident. A co-operative agreement was entered into, whereby the Bureau of Mines was to investigate the underlying physical and chemical facts and make them public, and the Trent Corporation was to pay the cost of the investigation.

The several reports as made have been available to any one interested, and are now to be published. While the Bureau of Mines felt justified in investigating the physical phenomena so far as might be done in a laboratory, and so far as public interest might reach, no attempt was made to discover the commercial possibilities which development might bring. The question of commercial possibilities must be left for commercial enterprise to answer.

Briefly, the process consists in agitating together powdered coal, water and oil. This produces a partly de-ashed plastic fuel, called an amalgam, the oil selecting the coal particles and largely excluding the water and ash. The amalgam can be freed from water mechanically held by working much the same as butter is worked. The amalgam can be burned in several ways; for example, it may be shoveled, or forced through pipes by pressure; it can also be stored, under water if desired.

The laboratory results immediately suggest many interesting possible applications. For pulverizing fuel, wet grinding presents many advantages over dry grinding, provided the water can be eliminated afterwards.

To be able to reduce the ash in coal may make available great quantities of low grade coals and material now considered as waste at the mines.

If an oil is used which can be distilled at a temperature below the distilling temperature of the coal, powdered fuel is reclaimed from the amalgam and the oil may be re-used. If a heavy oil be used and distilled to dryness, a coke product may be recovered, although the coal used may have had no coking quality. If the distillation proceed only to a heavy pitch, a mass suitable for briquetting may be made.

In distilling oil mixed with a finely powdered material the distillates are similar to those obtained by distilling under pressure, so that the distillation of an amalgam of coal and oil gives quantities often more favorable than the sum of the separate distillations of the coal and the oil.

The amalgam can be used for a gas-making fuel, and gas-house tar emulsions can be dehydrated by mixing with powdered coal, the amalgam being retorted for further gas making.

Graphite ore can be separated from its gangue, and coke can be separated from flue dust by using the Trent process. Clean coal in anthracite sludge will make an amalgam if oil is added.

This brief sketch of possibilities revealed by small-scale laboratory work shows that the field for investigation and development is large. The general results show that real benefits are physically possible by treating coal in this manner. The Bureau has interested itself more particularly in the ash separation phenomena or the cleaning of coal, as outlined in the following paper, and in the distillation of the amalgam.

### Laboratory Studies of the Trent Process

When a mixture of pulverized coal and water is agitated with oil in an amount equal to 30 per cent of the weight of the coal, a clean separation of a considerable part of the mineral matter is obtained. The carbonaceous material forms with the oil a pasty agglomerate which is heavier than water, while the mineral matter which was physically separated from the carbonaceous material by the fine pulverization remains suspended and can be drawn off with the water.

### HISTORICAL

The history of coal washing has been similar to that of ore concentration. Hand picking has been supplanted by jigs, jigs have given way to tables in the treatment of the finer sizes of coal, and of late much attention has been given to the possibilities of froth flotation and other methods making use of the selective action of oils.

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Bacon and Hamor<sup>1</sup> in discussing the problem of the utilization of fuels, describe experiments carried on at the Mellon Institute by Dr. C. B. Carter on froth flotation of coals. He found that the combustible matter contained in washer waste of all grades could be almost completely removed by suitable oil flotation, with a recovery of combustible matter between 70 and 90 per cent. Best results were obtained with washer waste crushed to pass a 48-mesh screen. The coal particles showed maximum floating properties when they were sharp, angular, and lustrous. Grinding in machines of the disk type was found to destroy these physical properties and to make the yield of recovered coal from refuse ground in this manner small and its ash content high. Estimates showed that a plant to handle 500 tons daily of ordinary bituminous coal washer waste would cost \$135,000. With such an installation it was estimated that coal could be obtained from refuse containing 65 to 70 per cent ash to the extent of 75 per cent of the total coal present, in the form of dry 25 per cent ash concentrate at a cost of \$1.84 per ton. Pyrite was found difficult to remove by froth flotation.

Ernest Bury<sup>2</sup> and co-workers describe an investigation of froth flotation of coal carried out at the works of the Skinningrove Iron Co., England. These workers were able to obtain concentrates analyzing 9 to 14 per cent ash from washery wastes containing 40 to 75 per cent ash. The tailings contained 76 to 89 per cent ash. The authors believe that a considerable amount of pyrite may be removed by the process, although no sulphur analyses are given. The washed product, which forms as a thick heavy stable scum on the water surface of the froth boxes, contains about 50 per cent of moisture. This concentrate is discharged into revolving filters of the Oliver type, drained under suction, and discharged as a filter cake containing 10 to 15 per cent of moisture. The cost of cleaning coal by froth flotation is estimated as not greater than the cost of jig washing. In regard to the scope of froth flotation in coal cleaning, the authors state as follows: "The flotation method does not, of course, compete with washers treating nut coal for sale on the open market for boiler firing, etc.; it can be employed only where the original coal is fine or where crushing is part of the normal treatment—that is, for coking, gas-making, briquetting, coal dust firing, colloidal fuel, etc."

#### NATURE OF MINERAL MATTER IN COAL

The mineral matter in coal is classified (1) according to its physical state of subdivision as intrinsic and extraneous and (2) according to its chemical composition as shale, clay, slate, sand, calcite, and pyrite. Intrinsic impurities are those which are present in a very fine state of dissemination throughout the coal substance and are not separated from the coal substance even by very fine pulverization. This intrinsic mineral matter is partly derived from the original material and partly deposited during the laying down of the coal bed from external sources by sedimentation and precipitation. Extraneous impurities occur in the form of partings, veins, and nodules or may be impurities mechanically mixed with the coal during the process of mining. Part of this extraneous mineral matter is

removed by the standard methods of washing coal, the amount removed depending on the fineness of crushing necessary to physically separate mineral matter from coal substance, and on the size of crushed coal which the washery can efficiently treat.

#### DIFFERENCES BETWEEN COAL AND ORE CONCENTRATION

There are certain obvious differences between concentrating coal and concentrating ore. In ore concentration the valuable material is heavier than the gangue and constitutes a small percentage of the total material treated. In coal concentration, the valuable material is lighter than the refuse and constitutes a large percentage of the total material treated. Furthermore, there is a larger difference in specific gravity between values and gangue in ore than in coal. Gangue in ore varies in specific gravity from 2.5 to 3.0 and values vary from 4 to 8, while the mineral matter in coal (with the exception of pyrite) varies in specific gravity from 2 to 2.7 and the clean coal concentrate from 1.2 to 1.7. Again, coal contains *extraneous* mineral matter easily separated by crushing and *intrinsic* mineral matter, none of which can be separated except by very fine pulverization. The crushed raw coal which is to be concentrated may contain particles of coal of varying gravities containing varying amounts of inseparable ash, making a clean separation impossible at the degree of fineness employed with ordinary washing methods.

One of the early processes of concentrating ores which made use of selective wetting was the Elmore bulk oil process. Elmore mixed the ore with several times its weight of water and an equal weight of oil in a revolving drum. After gentle agitation, the mixture was run into a spitzkasten, where the water and gangue settled to the bottom and were removed. The ore was separated from the oil by a centrifugal apparatus. Froth flotation, employing an amount of oil equal to about 1 lb. per ton of ore treated or less than the recovery losses in the bulk oil processes, has superseded the Elmore process in the treatment of ore.

Since the further history of the coal concentrate is to be different from that of the ore concentrate, it does not necessarily follow that methods using relatively large amounts of oil are impracticable for concentrating coal even though such methods have been practically abandoned in ore concentration practice. The ore concentrate is to be passed through a metallurgical operation for the recovery of the pure metal; the coal concentrate is to be used ultimately as a fuel and in many cases is to be subjected to distillation for the production of coke. The mixture of coal and oil may be burned without further treatment or it may be carbonized with the formation of coke and recovery of the oil and by-products from the coal. If the oil employed contains a considerable percentage of pitch, it may serve to make coherent coke from feebly coking coals.

#### SCOPE OF WORK OF THE BUREAU OF MINES

The work at the Bureau has been carried out rather on the fundamentals of the bulk oil method than on its economic aspects. Experiments on a laboratory scale have been made to determine for a variety of coals the ash and sulphur removal, combustible recovery, and oil losses with different oils, different methods of agitation, and various degrees of fineness of pulverized coal. The experimental procedure followed has aimed to obtain data giving a complete balance sheet of the process.

<sup>1</sup>Bacon, Raymond F., and Hamor, William A. Problems in the Utilization of Fuels, *J. Soc. Chem. Ind.*, vol. 38, June 30, 1919, pp. 161-168.

<sup>2</sup>Bury, Ernest; Broadbridge, Walter, and Hutchinson, Alfred: Froth Flotation as Applied to the Washing of Industrial Coal, *Trans. Inst. Mining Eng.*, vol. 60, February, 1921, pp. 243-253.

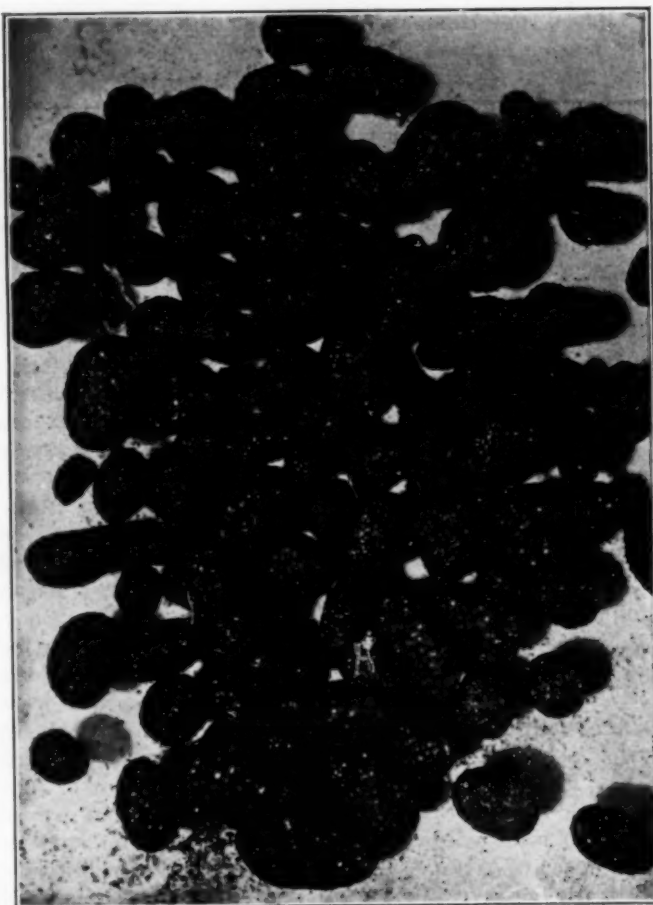
The bulk oil method of cleaning coal depends upon the same principles of selective wetting which have made possible froth flotation of ores and have been voluminously discussed in the literature of flotation. When oil is stirred into a suspension of coal in water, the first tendency is probably the formation of a suspension of droplets of oil in the mixture. The coal particles are, however, so readily wet by oil in preference to water that the globules rapidly become small agglomerates of coal and oil. These agglomerates tend to adhere to one another, entrapping water in the spaces between them and forming the pasty mass which precedes the breaking of the mixture. As a result of further agitation, the small agglomerates coalesce into larger granules and finally coalescence reaches a point where a large amount of water is released from between the particles and the separate granules are visible. With further agitation, the granules agglomerate into larger masses and if sufficient oil has been added, finally form a more or less homogeneous mass.

The best conditions for rapid formation of this amalgam<sup>3</sup> are (1) low surface tension between coal and oil, (2) a high surface tension between coal and water, and (3) a high surface tension between oil and water. Or in other words, the reaction will take place most readily (1) with a coal which is very readily wet by oil, (2) with a coal which is not readily wet by water, and (3) with an oil which does not readily form emulsions with water. From (1) and (2) we should expect that the bituminous coals and graphite should respond to treatment most readily and the lignites least readily. From (3) we should expect gasoline and the higher paraffine oils to form an amalgam more readily than benzene and the higher aromatics and that the presence of substances in water or oil which tend to lower the surface tension between water and oil, would make the formation of the amalgam more difficult. Particles of refuse which have been physically separated from the clean coal particles by the preliminary pulverization, will be easily removed if they are readily wet by water in preference to oil and removed with difficulty if they have any tendency to be wet by oil. Hence we should expect that shale, clay and gypsum would be readily removed suspended in the water but that pyrite might tend to remain in the amalgam.

#### METHODS AND APPARATUS FOR LABORATORY SCALE WORK

Coal is pulverized to pass a 65-mesh screen in a laboratory disk crusher. For finer meshes the coal is then ground in a porcelain ball mill with an equal weight of water, for periods varying from 4 hr. to as long as 60 hr. when extremely fine grinding is desired (as fine as 800-mesh has been obtained in this manner). The coal is washed from the ball mill into a settling jar, from which after settling has taken place and some of the water has been decanted, it is transferred to a small electrically stirred glass churn—300-g. samples of coal have been employed in most of our work and have been agitated in the churn with about 900 cc. of water. A sufficient quantity of oil is added—about 25 per cent of the weight of the coal for a coal containing 25 per cent removable refuse—and agitation is carried on until the agglomerate of small egg-shaped granules known as the amalgam is formed.

<sup>3</sup>In ordinary technical usage, amalgam refers to an alloy of a metal with mercury, but the term is correctly used according to Webster's dictionary, to refer to any "mixture, compound, or union of different things."



AMALGAM GRANULES, NATURAL SIZE

The amalgam and water and suspended refuse are poured onto a 100-mesh screen and washed with water. The amalgam is then placed in the churn and washed with fresh water and the process repeated until no further mineral matter is removed.

After the amalgam has been separated from the refuse and the refuse filtered on a weighed paper, the products for analysis are:

- (1) Amalgam, consisting of purified coal, oil, and 10 to 30 per cent water.
- (2) Refuse, consisting of mineral matter, a small amount of combustible matter, oil, and water.
- (3) Refuse water, consisting of all the water used in the process with the exception of that retained in the amalgam and filtered refuse, a small amount of dissolved mineral matter, and under certain conditions possibly emulsified oil.

Before analysis can be made, both amalgam and refuse must be separated from oil and water. This separation must be done in a quantitative way so that oil losses, if any, may be determined. The obvious way of separating the oil is extraction of amalgam or refuse with a solvent which dissolves the oil but does not affect amalgam or refuse. If this solvent boils at a higher temperature than water, the water may be condensed and measured, thus determining amounts of oil and water in one operation. Due to the large amount of water in amalgam and refuse and the difficulty of accurately sampling the wet amalgam, it has been found more practicable to subject the whole amalgam and refuse to a separate distillation at 110 deg. C. in which water is caught and measured. The dry material is then extracted with benzene to determine the percentage



TABLE I. DESCRIPTION OF COALS TESTED

Classes of Coal	Seam	Source	Designation
Anthracite culm.....	.....	Secured from Trent Process Corporation, Washington, D. C.....	Anthracite culm I.
Anthracite culm.....	.....	Feed to concentrating tables at washery of Hudson Coal Co., Scranton, Pa.....	Anthracite culm II.
Anthracite.....	.....	Rhode Island anthracite.....	Rhode Island
Bituminous.....	Pittsburgh.....	Pulverized coal from plant of Oliver Iron and Steel Co., Pittsburgh.....	Pittsburgh
Bituminous.....	Upper Freeport.....	Run-of-mine coal from Avenue Mine of Allegheny Steel Co., Brackenridge, Pa.....	Upper Freeport I
Bituminous.....	Upper Freeport.....	Feed to washery at mine of Inland Collieries Co., Harmarville, Pa.....	Upper Freeport II
Bituminous.....	Upper Freeport.....	Bone coal refuse from washery of Inland Collieries Co., Harmarville, Pa.....	Bone coal
Bituminous.....	No. 6.....	Run-of-mine coal, No. 1 Mine, Superior Coal Co., Gillespie, Ill.....	Illinois I
Bituminous.....	No. 6.....	Run-of-mine coal, No. 7 Mine, Big Muddy Coal and Iron Co., Herrin, Ill.....	Illinois II
Bituminous.....	No. 6.....	Run-of-mine coal, No. 12 Mine, Vandalia Coal Co., Sullivan, Ind.....	Indiana
Bituminous.....	Lehigh.....	Run-of-mine coal, No. 5 Mine, Folsom Morris Coal Mining Co., Lehigh, Okla.....	Oklahoma
Bituminous.....	.....	Run-of-mine coal from cars at mouth of mine, Wilkeson Coal and Coke Co., Wilkeson, Wash.....	Washington bituminous
Bituminous.....	.....	Coal from Brazil, secured from Trent Process Corporation.....	Brazil
Bituminous refuse.....	Blossburg.....	Waste from washery of Phelps Dodge Co., Dawson, N. M.....	New Mexico
Bituminous refuse.....	Soddy.....	Washer refuse from washery of Durham Coal and Iron Co., Soddy, Tenn.....	Tennessee
Bituminous refuse.....	Black Creek.....	Washer refuse from washery of Black Creek Coal Co., Nauvoo, Ala.....	Alabama
Sub-bituminous.....	.....	Run-of-mine coal from bins at head of washery, plus the bone from the picking table Pacific Coast Coal Co., Issaquah, Wash.....	Washington sub-bituminous
Lignite.....	.....	Run-of-mine coal, No. 1 Mine, Bertetti Coal Co., Lytle, Texas.....	Texas lignite
Lignite.....	.....	Run-of-mine coal, Kassick Cattle Co., Ione, Cal.....	California lignite

of oil. When a volatile liquid such as benzene is used in making the amalgam, distillation determines the amounts of both water and benzene and no extraction is necessary. Even when heavy petroleum oils are used in making the amalgam, it is best to dry in the still because a small portion of the oil always comes over with the water. Drying in an open dish would thus give rise to an unaccounted for loss of oil.

#### ASH REDUCTION AND COMBUSTIBLE RECOVERY

In calculating the efficiency of the process, several values are of interest; three of the most important being (1) per cent ash in the oil-and-water-free cleaned coal; (2) per cent ash reduction; (3) per cent combustible recovery. The first two values are qualitative measures of the efficiency. Per cent ash reduction equals the per cent ash in the raw coal minus the per cent ash in the cleaned coal, divided by the per cent ash in the raw coal. Per cent combustible recovery is a quantitative measure of the efficiency of separation of combustible matter from mineral matter. It is equal to

$$\frac{C - rc}{C}$$

where  $C$  is the per cent combustible matter in the raw coal,  $c$  the per cent combustible matter in the refuse, and  $r$  is the per cent refuse by weight of the raw coal.

In calculating the amount of combustible matter in coal or refuse, it must be borne in mind that combustion of carbon is not the sole reason for loss in weight when coal is ignited in the analytical method for determina-

tion of ash. There is always a larger amount of mineral matter in coal or refuse than represented by the percentage ash as determined by the ordinary analytical method. For example, a refuse which shows 85 per cent ash remaining after ignition to constant weight at 750 deg. C. does not contain 15 per cent combustible matter. Several factors contribute to this loss in weight: Combustion of carbonaceous material; decomposition of carbonates; oxidation of pyrite to  $\text{Fe}_2\text{O}_3$  and  $\text{SO}_2$ , and combination of part of the  $\text{SO}_2$  with oxides formed from decomposed carbonates; loss of water of hydration from clay and shale.

Water of hydration varies from 2 to 12 per cent of shale, calcium carbonate is present in small amounts in the coals of the Appalachian fields, but may run as high as 50 per cent of the ash of some of the Illinois coals. Parr<sup>4</sup> has proposed a formula for calculating the corrected ash which involves the per cent carbon occurring as carbonate in the unburned coal. In our work, time has not been available for the determination of carbonate in the refuse and the corrected ash has been determined as follows:

$$\text{Ash corrected} = 1.08 \text{ ash} - \frac{21}{40} S$$

Any correction factor must of necessity be an approximation, the correctness varying according as the composition of the ash varies from the assumptions made in deriving the formula. The water of hydration which

<sup>4</sup>Parr, S. W., Preliminary report of committee on coal analysis: *J. Ind. Eng. Chem.*, vol. 5, June, 1913, p. 523.

TABLE II. SUMMARY OF TRENT PROCESS RESULTS

Kind of Coal	Lab. No.	Amount of Oil Used, Gal. per Ton	Raw Coal			Cleaned Coal			Refuse				Efficiency				Time of Agita- tion, Hours
			Ash	Corrected Ash	Sulphur	Weight	Ash	Sulphur	Weight	Ash	Corrected Ash	Sulphur	Ash Reduction	Combustible Recovery	Sulphur Reduc- tion		
																Per Cent	
Anthracite culm I.....	34,647	65	27.7	30.4	1.00	74.0	7.0	0.70	26.0	87.0	95.0	1.99	74.7	97.8	30	0.5	
Anthracite culm II.....	76,975	65	31.4	34.8	1.63	69.0	6.5	0.85	31.0	87.0	95.6	3.05	79.2	98.0	48	0.5	
Anthracite, Rhode Island.....	78,127	75	21.7	23.8	0.85	82.0	6.7	0.83	18.0	90.7	98.3	0.95	69.2	99.5	..	2.0	
Bituminous, Pittsburgh.....	34,768	80	12.5	14.2	1.27	92.0	6.0	1.34	8.0	88.0	95.2	0.40	52.0	99.5	..	0.1	
Bituminous, Upper Freeport.....	76,974	80	9.3	11.2	2.28	96.5	6.7	2.34	3.5	87.6	94.8	0.60	28.0	99.7	..	2.0	
Bituminous, bone coal refuse.....	34,645	80	21.7	23.9	0.93	88.0	12.5	0.80	12.0	88.7	96.9	2.08	42.3	99.4	14	1.0	
Bituminous, Illinois.....	75,637	80	16.6	20.7	5.33	85.0	7.4	5.28	15.0	69.7	76.6	2.25	55.4	89.8	1	3.0	
Bituminous, Indiana.....	76,027	80	9.9	13.0	4.38	96.4	6.3	4.27	3.6	86.2	93.5	0.80	36.4	99.8	3	0.5	
Bituminous, Oklahoma.....	75,631	80	19.5	23.6	4.74	69.0	5.7	3.08	31.0	50.5	59.0	8.50	70.8	83.5	35	2.0	
Bituminous, Washington.....	76,142	80	22.6	24.7	0.49	87.5	13.6	0.50	12.5	85.0	92.1	0.50	39.8	98.7	..	0.5	
Bituminous, refuse, New Mexico.....	77,989	60	54.7	59.3	0.55	45.0	22.9	0.86	55.0	80.6	87.3	0.29	58.1	82.8	..	2.0	
Bituminous, refuse, Tennessee.....	77,541	50	63.5	69.4	1.64	31.0	20.6	1.48	69.0	82.7	90.2	1.65	67.7	77.8	10	2.0	
Bituminous, refuse, Alabama.....	77,864	80	23.5	26.2	1.60	80.5	6.6	1.76	19.5	92.8	100.7	0.90	72.0	100	..	1.0	
Sub-bituminous, Washington.....	75,897	80	19.3	21.1	0.48	87.0	10.0	0.50	13.0	80.0	86.7	0.45	48.4	97.8	..	3.0	
Lignite, California (a).....	76,026	80	35.1	39.3	1.77	81.5	25.7	1.56	18.5	75.9	83.2	2.30	26.8	95.0	12	2.0	
Lignite, Texas (a).....	75,823	80	33.5	36.9	1.44	79.7	18.1	1.42	20.3	94.2	102.4	1.25	46.0	100	1	2.0	
Bituminous, Brazil.....	78,226	60	35.6	39.7	2.47	66.0	9.4	2.32	34.0	86.0	94.4	2.71	73.6	97.0	6	4.0	

(a) Carbonized at 500 deg. C.

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is present in shales may vary from 2 to 12 per cent. Part of the sulphur is present as organic sulphur while the formula assumes the sulphur is all present as pyrite. Since little organic sulphur is removed with the refuse, the sulphur correction is fairly accurate.

Table I gives a description of the coals discussed in the present article. These coals are referred to in the remaining paragraphs as noted in the column under "designation."

Table II gives averages of results with a number of typical coals of the United States. The coals were pulverized to 65 mesh and ground for 6 hr. with an equal weight of water in a laboratory ball mill before treatment by the Trent process. The oil employed was in all cases a grade of Navy fuel oil running 125 seconds on the Saybolt viscosimeter at 25 deg. C. The specific gravity of the oil was 0.875 (30.0 deg. Bé.) at 20 deg. C.

The results as set down are for the most part self-explanatory. It will be seen that ash reduction with most of the coals tested is good, varying from 30 to 75 per cent. Sulphur reduction is fairly good in the case of anthracite coals but low in the case of bituminous coals. With these latter coals just sufficient sulphur is removed to keep the sulphur content of the recovered coal about the same as that of the raw coal. Combustible recovery is with a few exceptions better than 95 per cent.

#### SULPHUR REMOVAL

The removal of pyrite from coal by any process depending on the selective action of oils is considerably more difficult than the removal of other mineral matter such as shale or slate. Pyrite is readily wet by oil and particularly when in a fine state of sub-division tends to attach itself to the coal-oil agglomerates rather than remain suspended in the water. Separation is accomplished with greater ease from anthracites than from bituminous coals. This difference in behavior of anthracite and bituminous coals is shown in the following analyses giving the percentage of total sulphur, sulphate sulphur, pyritic sulphur, and organic sulphur in a bituminous and an anthracite coal before and after treatment by the Trent process. It will be seen that in the treatment of anthracite coal, the pyritic sulphur almost disappeared from the recovered coal, while in treating the bituminous coal there was still a considerable percentage of pyritic sulphur remaining in the recovered coal.

Coal	Condition	Ash	Analysis of Sulphur			
			Total	Pyritic	Sulphate	Organic
Oklahoma bituminous, No. 75631	Raw . . . .	19.5	4.74	3.01	0.36	1.37
	Recovered	7.9	3.75	2.10	0.15	1.50
	Refuse . .	46.3	6.50	4.85	0.35	1.30
Pennsylvania anthracite culm, No. 76975	Raw . . . .	31.5	1.74	1.21	0.06	0.47
	Recovered	7.0	0.85	0.13	0.07	0.65
	Refuse . .	66.1	2.73	2.41	0.01	0.31

A study of synthetic mixtures of coal and pyrite was made with a view to determining definitely the percentage of pyrite which might be removed from a mixture in which the pyrite was known to be separated from the coal particles. With mixtures of bituminous coal and pyrite ground to pass a 200-mesh sieve, separation of about 60 per cent of the pyrite was obtained by means of the Trent process, but practically no separation was obtained when this mixture was ground to 600-mesh or finer. Better separation was obtained with mixtures of anthracite coal and pyrite. The pyrite refuse separated

from the various mixtures always retained considerable amounts of oil, pointing to the fact that where separation of pyrites was obtained in the coarser mesh mixtures, this pyrite was mechanically separated from the amalgam by reason of its high density and still retained a film of oil. Coal pyrite containing about 46 per cent sulphur was used in the experiments. It was found possible to make an amalgam of the wet ground pyrite alone with very little of the pyrite remaining suspended in the water.

Results point to the desirability of preliminary water concentration of high sulphur coals for removal of pyrite before treatment by the Trent process.

#### OIL EMPLOYED IN PROCESS

Any oil or organic liquid not miscible with water may be employed in the Trent process provided its viscosity is not too great. The heavy topped crudes may be employed if the water used in the process is heated, thus reducing the viscosity of the oil. Certain commercial emulsions such as water-gas tar or B.S. petroleum emulsions have been successfully employed. Here again the viscosity must not be too great. B. S. refinery settlings of the consistency of cup grease were not found to be satisfactory at ordinary temperatures. An oil of viscosity equal to 135 sec. (at 25 deg. C.) on the Saybolt viscosimeter gives satisfactory results. When oils of viscosity equal to 400 sec. and upwards are employed, it is necessary to employ heated water to secure best results. Using an oil with a viscosity equivalent to 4,000 sec. Saybolt, at room temperature, it was found necessary to heat the water to 70 deg. C. to effect formation of the amalgam.

Apparently the efficiency of ash separation begins to diminish when an oil greater in viscosity than about 40 sec. Saybolt is employed. Combustible loss in the refuse is somewhat less with the more viscous oils. Considerably more of the liquids of low viscosity such as benzene and carbon tetrachloride must be used to obtain a coherent amalgam than of the oils of higher viscosity.

In the greater part of our work, oil has been used in an amount equal to 0.3 lb. per lb. of dry cleaned coal. If a coal contains 25 per cent of removable refuse, it will be necessary to use 450 lb. or about 62 gal. of a light fuel oil per ton of raw coal treated. With coal ground to pass a 200-mesh screen, this quantity of oil produces an amalgam in granules about 1/4-in. in diameter. If finer ground coal is employed, it may be necessary to use as much as 0.4 lb. of oil per lb. of dry cleaned coal. It is best to work with as small an amount of oil as possible because better washing of the amalgam is possible when the granules are fairly small, and the resultant cleaned coal contains less ash.

#### OIL LOSSES

**Emulsification.** Although at first sight it might be thought that considerable oil would be lost as a result of emulsification in the water, experiments have shown no appreciable loss due to this cause. Apparently the presence of finely pulverized coal in the water effectively prevents emulsification. As a matter of fact, certain commercial emulsions such as water-gas tar and B. S. emulsion are broken down by the addition of pulverized coal and may be used as oils for carrying out the Trent process. Even if a certain amount of oil were retained in the water, the use of this water over again after separation of the refuse, would eliminate loss from this source.



**Absorption in the refuse.** The oil retained by the refuse is seldom more than 1 per cent of the total oil used and frequently is practically zero. In certain cases where a large amount of refuse high in carbon and pyrite has been removed, the oil absorbed in this refuse has been as much as 10 or 15 per cent of the total oil used.

**Volatilization.** Volatilization losses are negligible with the heavier petroleum oils but of course quite appreciable in the case of gasoline or benzene. It is hardly likely, however, that such volatile oils will be used in any commercial application of the process.

Our results point to the conclusion that oil losses in the first stage of the process, i.e., agitation and separation of refuse, will be negligible. Recovery of oil from the amalgam by distillation is another matter and one outside the scope of the present article.

#### AMOUNT OF WATER RETAINED IN THE AMALGAM

An amalgam in granules  $\frac{1}{8}$ -in. or larger usually retains 8 to 12 per cent moisture which will not drain out of the mixture, in addition to the hygroscopic moisture of the coal. It has been found possible to reduce this moisture to about 5 per cent by passing through a kneading machine of the meat chopper type. In an amalgam of very fine granules, the moisture content may be as high as 30 or 40 per cent. A large part of this moisture occurs as a coating of the small particles and is separated by further agitation or the addition of more oil to effect the formation of larger granules. The size of the granules depends upon the amount of oil used, the size of the coal particles, the method of agitation and time of agitation and to some extent on the character of the coal. Certain sub-bituminous coals require more oil to produce granules of a given size than do the bituminous coals or anthracite.

Brisk agitation of the kind given by rapidly revolving paddle blades is most efficient in separating mineral matter from coal and in securing rapid formation of the amalgam.

#### TIME REQUIRED FOR FORMATION OF THE AMALGAM

Coals differ very much in the rapidity with which they form the so-called amalgam. As a general rule, it may be stated that coals containing more than 3 or 4 per cent hygroscopic moisture as received will be difficult to work. When they contain 20 or 30 per cent moisture as do the lignites, separation is practically impossible even with prolonged agitation.

It has not been found possible to get good separation of carbonaceous material from mineral matter by treatment of the raw lignite. Lignites are very readily wetted by water, and once the lignite is well wetted with water, either by wet grinding or by soaking, the water is not readily displaced by oil. On agitation of a wet ground mixture of lignite with oil, there is some tendency for separation into layers of coal-oil and refuse-water, but no formation of the compact agglomerate of coal and oil which takes place with bituminous coals or anthracites. Microscopic examination of the mixture shows globules of oil suspended in the mixture of lignite and water indicating a high surface tension between the oil and the coal-water mixture.

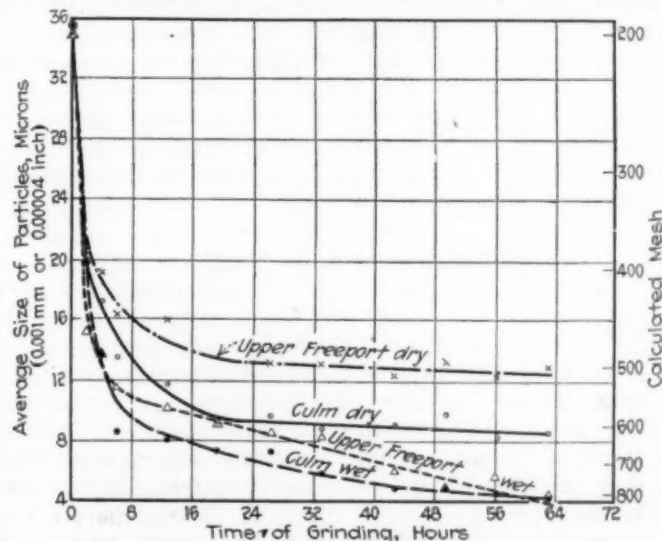
Inspection of Table I will show that the two samples of lignite were carbonized at 500 deg. C. before treatment. Mere drying of the coal at 110 deg. C. is not sufficient. The structure of the coal is not changed by such treatment and the water so driven off is re-absorbed

when the coal is soaked in water prior to treatment by the Trent process. It is necessary to carbonize the lignite at a sufficiently high temperature to so change its structure that it is no longer hygroscopic. When this is done and the carbonized material finely pulverized by grinding in the ball mill, the formation of the amalgam takes place readily although a large ash reduction is not obtained with the brown woody lignites. The mineral matter in these lignites is apparently very finely disseminated throughout the coal substances and complete separation is not attained even at the finest degree of pulverization possible by grinding in the ball mill or about 5 microns (0.005 mm.).

In considering the efficiency of the Trent process in cleaning a given coal, we must then consider a third factor—time of agitation—in addition to ash reduction and combustible recovery. This factor assumes importance with the sub-bituminous coals and lignites. Obviously, overhead expenses will become greater as the time of agitation increases and there will be a length of agitation beyond which it will not be profitable to go. In the following table are set down analyses of a number

Name of Coal	Time of Agitation		H <sub>2</sub> O	Vol. Matter	Analysis		
	First Separation Min.	Completion Min.			Fixed Carbon	Ash	Sulphur
Pittsburgh.....	1	10	1.53	33.42	52.72	12.33	1.25
Upper Freeport I.....	2	30	1.50	34.40	54.92	9.18	2.25
Illinois II.....	2	30	2.50	31.87	52.42	9.93	1.28
Illinois I.....	30	180	10.93	36.22	40.30	12.55	4.03
Oklahoma.....	5	120	5.10	35.80	41.40	17.70	4.46
Indiana.....	1	30	1.75	42.75	45.80	9.70	4.19
Texas lignite.....	60	∞	26.68	31.97	26.55	14.80	1.41
Texas lignite, carbonized.....	20	120	0.05	10.95	55.50	33.50	1.44
Calif. lignite.....	60	∞	15.20	48.31	21.29	15.20	1.60
Calif. lignite carbonized.....	30	120	0.05	19.05	45.80	35.10	1.77
Anthracite culm I.....	2	30	2.15	7.27	64.87	27.70	1.00

of coals together with the time for which it was found necessary to agitate these coals when treating them by the Trent process. Two figures for time of agitation are given, the first column being the time the mixture was agitated before a separation into small agglomerates of coal and oil were visible. At this time the granules of coal and oil are soft and cannot be separated from the refuse by screening. After a further period of agita-



COMPARISON OF WET AND DRY BALL MILL GRINDING OF ANTHRACITE CULM AND UPPER FREEPORT BITUMINOUS COAL

Original samples first ground dry to pass a 200-mesh screen. Right-hand ordinate represents calculated mesh of screen through which entire sample would pass at time of grinding indicated.

tion, the granules become larger and more coherent, and may be filtered from the refuse and water by screening. The figures in the second column show the total time taken for agitation and screening of the amalgam and for the several agitations in fresh water for removal of the last traces of refuse.

The Trent process is unique among coal cleaning methods in that it treats coal in a very finely pulverized condition. Any advantages which are obtained by treatment of finely pulverized coal are advantages peculiar to the process. In the course of the investigation, a considerable amount of work has been done to determine the relation between fineness of grinding, ash removal, and combustible recovery or in other words to show to what degree of fineness it is necessary to grind different coals in order to secure optimum separation of mineral matter from combustible matter.

It was found that grinding finer than 200-mesh does not give sufficiently greater ash reduction to pay for the increased cost of the finer pulverization. The percentage of combustible matter in the refuse decreases with finer pulverization but it may not be sufficient to warrant the added expense of grinding from 200-mesh to 600-mesh or finer. Sulphur reduction is in general at a maximum with the 200-mesh material.

A number of comparative determinations of the fusibility of ash in raw and cleaned coal were made. Where any considerable amount of ash has been removed, the ash from the cleaned coal shows either a slightly higher softening temperature or larger softening interval. This was not true in the case of the bituminous coal from Oklahoma.

#### SUMMARY

This paper has presented the results of laboratory-scale tests of the efficiency of the Trent process in cleaning coal. A noteworthy feature of the operation of the process is the cleanness of separation of mineral matter from combustible matter. Combustible recovery has averaged better than 95 per cent. High ash reduction has been obtained with the bituminous coals and anthracites. Sulphur reduction has been good in the case of anthracites but poor with the bituminous coals. It has not been found feasible to treat the lignites without preliminary carbonization, due to the difficulty of forming a coherent agglomerate of the raw lignite and oil. Finer pulverization than 200-mesh does not give a sufficient increase in ash reduction with most coals to warrant the added expense of the longer period of grinding. Any oil whose viscosity is not too great may be employed in the process. Oil losses in the refuse or water are apparently negligible.

#### Beet-Sugar Industry in Northern France

France before the World War had attained a high rank among the sugar-producing nations. From its beginning under the First Empire, attaining in 1830 a production of 3,000 tons, it reached 272,000 tons in 1884, with 148,000 hectares (365,714 acres) in cultivation. In 1901-2 France planted 312,000 hectares (770,965 acres) of beets and refined 1,051,000 tons of sugar. This was the largest annual production recorded and is attributed to favorable legislation then in force. The convention of Brussels, which suppressed the practice of subsidizing sugar exports, had thereafter an unfavorable effect upon the sugar industry, so that in 1913-14 only 216,200 hectares (534,230 acres) were planted and only 712,000 tons of sugar produced.

At the outbreak of the war the invasion of the northern department reduced by 54 per cent the acreage planted. The bad quality of the seed, the scarcity of labor, and the persistently increasing difficulty of procuring fertilizer diminished the yield by about 57 per cent, as the following table will show:

Season	Acreage Hectares	Sugar Refined Metric Tons	Season	Acreage Hectares	Sugar Refined Metric Tons
1914-15.....	98,250	302,000	1917-18.....	66,305	200,000
1915-16.....	63,209	135,000	1918-19.....	59,908	110,000
1916-17.....	60,000	185,000			

NOTE—One hectare equals 2.471 acres.

The difficulty of bringing in colonial or other sugar forced the government to restrict consumption, which fell from 710,000 in 1914 to 412,000 tons in 1919, of which last 300,000 tons were imported. At the end of 1919 the price of sugar was fixed by the government at 290 fr. per 100 kilos; a decree of June 28, 1920, raised it to 310 fr. Quotations on uncontrolled sugar rose rapidly to 400 francs during the month of August, and declined rapidly in October, and in November it was quoted at 170 fr. for 100 kilos.

Out of about 210 sugar factories that were running in France before the war 170 were located in the invaded departments: Nord, Pas-de-Calais, Somme, Aisne, Oise, Marne, and Ardennes. Of these 135 were damaged by the German invasion. These damaged factories had a total capacity of 490,000 tons of sugar each season of about 75 days per year.

The total damage is estimated at 250,000,000 fr. (value in 1914). Almost all these establishments will require total rebuilding. In 1919 a few plants in the Oise, which was only moderately damaged, and one in the Nord, recommenced work. In 1920 three damaged factories in the Nord, one in the Somme, and three in the Aisne resumed activity, with a total capacity of 3,000 tons of beets per day. The advanced state of reconstruction of factory building, and the manufacture of apparatus permit the estimate that during 1921 six plants in the Nord, one in the Pas-de-Calais, one in the Somme, and four in the Aisne will resume operations. As well as can be at present foreseen, about 20 plants will recommence work in 1922, and the whole program of reconstruction will be completed in 1925.

It is estimated that out of the 135 damaged plants, about 20 will be abandoned entirely, or for a number of years, or will be employed in other industries. Among those in process of rebuilding, a certain number will increase their former capacity, several plants being consolidated in one new one. The number of establishments will be reduced, but the total capacity will not follow the same diminution. The forecast of the future sugar production is given as follows:

1920-21.....	350,000	1923-24.....	550,000
1921-22.....	460,000	1924-25.....	580,000
1922-23.....	530,000	1925-26.....	600,000

The materials and machinery necessary to be replaced or repaired is large, and for the present, French foundries and machine shops are counted upon almost entirely. Fortunately the rapid reconstruction of the industrial plants of northern France have permitted them to take care of orders since the end of 1919. American and English constructors have been temporarily eliminated from the market on account of the exchange rate. German bids have not been much lower than the French for this work, and in view of the uncertainty of deliveries no orders have been given in that quarter. The reconstructed factories will in most cases be equipped with new and improved machinery.



# The Colloid Chemistry of Petroleum

## A Description of the Two-Phase Petroleum System Found in Oil Emulsions —Emulsifying Agents—Types of Emulsions—Breaking an Emulsion— Effect on Lubrication and Plant Practice—Products

By FRED W. PADGETT\*

COLLOID chemistry has lately been defined<sup>1</sup> as the chemistry of bubbles, drops, grains, filaments and films. To anyone familiar with petroleum and its products this definition suggests an important relation to hydrocarbon technology. That petroleum and petroleum distillates are of a colloidal nature has been indicated by several investigators. Ostwald<sup>2</sup> entertains the belief that high-boiling petroleum fractions are to be regarded as iso-colloids in which the disperse phase and dispersion means possess the same or analogous chemical composition. Pyhälä<sup>3</sup> considers that crude petroleum is a sol, of which the disperse phases are solid gels, such as asphalt, together with liquid particles. Holde<sup>4</sup> has made the following observations concerning petroleum oils and distillates: Mineral oils are to be regarded as colloids. A solution of precipitated lime soap in benzene and in benzene-alcohol also behaves as a colloid. The heavy, opaque mineral oils, which are regarded as solutions of asphalt and lighter mineral resins in mineral oil, behave as colloids when viewed in benzene solution. Reddish yellow machine<sup>5</sup> oils and white paraffin oils displayed a bluish cone of light containing microns. Small quantities of crystallized paraffins dissolved in benzene gave no cone of light, but in larger quantities a cone of light and submicrons were to be seen which became more intense or numerous the more concentrated the solution. Submicrons were scarcely to be found in Russian petroleum free from paraffin, but were readily detected in paraffin-base petroleum from America. The fluorescence of petroleum has been attributed to the colloidal nature of the product, but Brooks and Bacon<sup>6</sup> reported that the fluorescent material was not adsorbed by fullers earth, and that, when a highly fluorescent oil was diluted with kerosene, filtered and carefully dried, there was no reaction with the ultramicroscope.<sup>7</sup> Brooks and Bacon's view is that fluorescence is caused by a small quantity of aromatics, such as chrysene, pyrene and fluorene.

### OIL EMULSIONS

An emulsion consists of drops of one liquid suspended in another liquid. Dispersed systems of this type, particularly the oil-water emulsions, are of practical importance in the technology of petroleum production and refining. The problem before the technologist may be to resolve the emulsion which is already

formed, or, on the other hand, may be to prepare a product which will form a stable emulsion; therefore a knowledge of the theory of emulsification,<sup>8</sup> especially if it is a good working theory, is of practical value.

Stable emulsions of any considerable concentration of dispersed phase must necessarily contain a third substance, an emulsifying agent, which is in colloidal solution in one of the phases, but is precipitated by the other.<sup>9</sup> Sometimes the emulsifying agent is not colloidal, but gathers at the interface in finely divided form, provided the substance adsorbs both phases simultaneously.

### EMULSIFYING AGENTS

What is the mechanism of a stable emulsion? Will the dispersed system be an oil-in-water emulsion, or the opposite, a water-in-oil emulsion; or both together? This may be illustrated by considering a hypothetical mixture of neutral oil and distilled water, the latter containing the emulsifying agent, potassium oleate, in colloidal solution. The addition of the soap to the water has lowered the surface tension on the water side of the interface more than on the oil side; consequently the interface will tend to curve so as to be convex on the water side, producing an oil-in-water emulsion when the mixture is shaken.<sup>10</sup> But there is nothing to prevent the drops from coalescing unless they have acquired like electric charges, have become surrounded by an adsorbed film of emulsifying agent, or are exceedingly small. If the drops have become surrounded by an adsorbed film of emulsifying agent, then the permanency of the emulsion will depend upon the stability of the film. If the emulsifying agent goes into colloidal solution with one of the phases, but is precipitated by the other, then the latter phase is dispersed and it will be possible to disperse water in oil, or oil in water, depending upon whether or not the emulsifying agent is a "hydrophobe" or "hydrophile" colloid. Sodium and potassium soaps are soluble in both water and oil, but, according to Fischer,<sup>11</sup> the soap, when dissolved in water, exists as a hydrated colloid which is not soluble in oil.

Is it always necessary to agitate violently a mixture in order to produce an emulsion? This will depend upon the "aggressiveness" of the emulsifying agent, and oils can be prepared which display such a marked

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<sup>1</sup>Bancroft's "Applied Colloid Chemistry."

<sup>2</sup>Ostwald's "A Handbook of Colloid Chemistry," p. 103.

<sup>3</sup>Z. Chem. Ind. Koll., vol. 9, p. 209 (1911).

<sup>4</sup>Z. angew. Chem., vol. 31, p. 2138 (1908).

<sup>5</sup>That optical heterogeneity of lubricating oils exists has been demonstrated by Dunstan and Thole (J. Inst. Pet. Tech., vol. 4, p. 191 (1918)), but they find that the degree of dispersion is high.

<sup>6</sup>J. Ind. Eng. Chem., vol. 6, p. 623 (1914).

<sup>7</sup>Unless oils are carefully dried and filtered they will show particles under the ultramicroscope and wrong conclusions as to the true dispersed nature of the product may be drawn.

<sup>8</sup>On modern conceptions of emulsions see Clayton, J. Soc. Chem. Ind., vol. 38, p. 113T (1919). Bancroft's classics on the subject appeared in J. Phys. Chem., vol. 16, pp. 177, 345, 739; vol. 17, p. 501; vol. 19, pp. 275, 513. See also Thomas, J. Ind. Eng. Chem., vol. 12, p. 177 (1920).

<sup>9</sup>Emulsifying agents giving colloidal solutions in water (hydrophiles) are sodium and potassium soaps of oleic acid, and gums such as gum tragacanth. Those giving colloidal solutions in oil (hydrophobes) are soaps of calcium, aluminum, magnesium, etc.; also lamp black.

<sup>10</sup>If both emulsions (water in oil and oil in water) are produced, it is reasonable to expect that one will be only temporary.

<sup>11</sup>Science, vol. 43, p. 468 (1916).

tendency to emulsify that, when they are poured upon water and permitted to stand, an emulsion results.<sup>13</sup>

#### TYPES OF EMULSIONS

Crude petroleum often comes to the surface emulsified with water; upon standing, a product known as "bottom settlings" collects in the storage tanks. These emulsions may be temporary, semi-permanent or permanent, and it is therefore evident that a method which has proved successful in breaking up one type of emulsion may be wholly unsuited for another. In the case of crude oil the stabilizing or emulsifying agent may be asphaltene, finely divided clay or dirt, or possibly soaps formed by the interaction of the salts in the water with traces of organic acids in the oil; then, too, the acquirement of electric charges of like sign by the drops of water may produce the effect of an emulsifying agent.<sup>14</sup> Combinations of the above-mentioned emulsifying or stabilizing agents may be of significance in regard to the stability of oil-field emulsions.<sup>15</sup> Generally, the more viscous an oil the more readily will it hold dispersed material, such as water and earthy matter.

As an example of the variability in character of crude oil emulsions, there may be mentioned a laboratory experience in the case of two crudes, one of 21 deg. Bé., very asphaltic and quite viscous, the other of 27 deg. Bé., less asphaltic and viscous than the first. Both oils were from the same lease, but from different sands, and both contained water in form of emulsion. Upon attempting to distill the first-mentioned oil it was found that the distillation could be carried out without the necessity of adding a solvent to bring over the water, although there was some bumping at the lower temperature where this occurred. In the case of the second oil, however, even after the addition of gasoline, or benzene and toluene, the distillation could not be completed without the oil foaming violently into the condenser when a certain point was reached. Only after diluting the crude with 15 per cent of light gasoline, permitting the mixture to settle, and drawing off the oil above the bottom settlings, was it found that a distillation could be made successfully even though some water was still present. The difference in behavior between the two oils is thought to be due to the presence, in the latter case, of finely divided clay or dirt.

#### BREAKING AN EMULSION

Many methods of resolving crude oil emulsions have been proposed and the most important may be enumerated as follows: Heating in various ways in open and closed systems; alternating- and direct-current electricity; centrifugal action; filtration, and chemical agents. Filtration through a filter composed of excelsior is advocated by one company which has a patented filter on the market. The writer has not had the opportunity of testing this method with emulsions of various types. The oil proceeds upward through the filter and, according to the claims, there is a considerable break in the emulsion with consequent separation

of B. S. As a chemical method there may be mentioned water-soluble soap, which has a tendency to produce the opposite kind of emulsion from that existing, the effect being to break up the emulsion already formed. Sherrick<sup>16</sup> has been able to discharge a crude oil emulsion by the use of ferric nitrate,<sup>17</sup> having previously made the observation that the drops of water in this particular emulsion were negatively charged. In actual practice it may be found advantageous to utilize combinations of the methods mentioned above. Thus, one company has developed a process which is a combination of closed heating, settling, direct-current electricity and centrifugal action. The writer is of the opinion that most crude oil emulsions may be successfully and economically resolved<sup>18</sup> by means of a closed heating system, properly designed to prevent the loss of volatile constituents; and that the more refractory emulsions will be treated ultimately by a method which is one of mild heating and contact with a substance which is slightly, if at all, consumed. There are also prospects of new electrical processes.<sup>19</sup>

The field is not the only place where troublesome emulsions are encountered in the petroleum industry. During the refining of lubricating oils with sulphuric acid, refractory dispersed systems of oil and water are likely to develop in the later stages of the process. In the laboratory it has been found that the formation of emulsions under these circumstances may be minimized if the alkali solution used is concentrated and the agitation is carried out with a hot solution.

#### EMULSIONS AND LUBRICATION

For general lubrication some engineers prefer an oil which will emulsify with water; but for use in continuous circulating systems, oils which possess sufficiently high resistance to emulsification are essential, since permanent emulsions would cause difficulties in the filtering and settling chambers where the process of purification usually consists only of screening, heating, settling and filtration. The recovery of used lubricating oils, such as those from crankcases, involves the removal of dirt which has accumulated from extraneous sources, colloidal decomposition products due to the more severe heat-treatment of the oil, water in form of rather permanent emulsion, and high ends from the gasoline used as fuel. Therefore the recovery of this type of used oil presents rather more difficulties than in the case of ordinary lubricants used in continuous circulating systems.<sup>20</sup> The production, during refining, of lubricating oils possessing high resistance to emulsification depends to some extent upon the character of the original crude oil, but more particularly upon the proper method of refining.

In plant and laboratory practice, wherever oil and water come into contact, emulsions are likely to be formed which may result in problems of major impor-

<sup>13</sup>Sherrick, *J. Ind. Eng. Chem.*, vol. 12, p. 133 (1920).

<sup>14</sup>Ferric chloride solution discharged the emulsion, but also produced jellies which were discharged by sodium nitrate.

<sup>15</sup>It may also be practical to study conditions in the well and to devise ways of preventing or minimizing the formation of emulsions as the oil comes from the sand to the storage tank. See McCoy, Shidel and Trager, *Bull. A. I. M. E.*, August, 1919, p. 1513.

<sup>16</sup>Other methods proposed for breaking up emulsions in general involve the use of sodium salts of sulphonates; heating under pressure; freezing; filtration through amorphous calcium and magnesium carbonates; various electrolytes, such as acids, aluminum chloride, cupric chloride, barium chloride, etc. The concentration of the electrolyte is of importance.

<sup>18</sup>One method is to blow the oil with steam, then to agitate with sodium carbonate solution, or a mixture of sodium carbonate and sodium soap. Final percolation of the dried oil through fuller's earth ought to be advantageous.

<sup>13</sup>In this connection consult the work of Roon and Oesper, *J. Ind. Eng. Chem.*, vol. 9, p. 156 (1917).

<sup>14</sup>See Sherrick, *J. Ind. Eng. Chem.*, vol. 12, p. 133 (1920).

<sup>15</sup>Richardson's definition of Trinidad asphalt from a colloidal standpoint will illustrate this: A suspension of relatively large-sized mineral particles in an extremely viscous medium, together with highly dispersed mineral matter in colloidal form intimately mixed with an emulsion of thermal water with the bitumen present. The colloidal mineral matter present has a high adsorption capacity for the bitumen of the asphalt, *J. Phys. Chem.*, vol. 19, p. 245, (1915).



tance, but often are but passing incidents of the day. An interesting phenomenon may be mentioned in connection with the operation of absorption gasoline plants. An investigation of slight discrepancies in determining the gravity of the charged absorbing oil disclosed the fact that the rapidity with which the sample was collected from the high-pressure oil-line effected the apparent gravity of the sample, due to the formation of an emulsion between the oil and a small quantity of water generally present. The rapidly drawn sample possessed the lowest apparent Baumé gravity, and this was also lower than that of the oil on its way from the vent tank to the still, for the reason that a large proportion of the water in the vented oil had been relinquished at the vent tank.

Another incident, reported by J. D. Underwood, may be noted in passing. An undesirable emulsified product was being produced from the water-trap attached to the expansion box of a steam-still, and was collecting in the separatory basins. Experiments with the product developed the fact that a small quantity of silt was present, probably acting as an emulsifying agent. The temperature in the expansion box was controlled by a direct spray of water in the auxiliary tower and the silt in the emulsified product no doubt originated from this source. Cleaner water used as a spray probably would have obviated the difficulty.

#### EMULSION PRODUCTS

In the preparation of certain petroleum products it is necessary to compound mixtures which will produce with water emulsions of a high degree of permanency. Examples are emulsifiable cutting oil (sometimes containing emulsifying agents in the form of phenolates, sulphonated castor oil or soaps), used for the lubrication of the cutting edges of tools; and spraying mixtures for trees, which have been prepared by the use of emulsifying agents in the form of water-soluble soaps, also finely divided basic copper and iron sulphates.<sup>10</sup> Detergent soaps<sup>11</sup> with a petroleum base may be compounded by dispersing mineral oil in a mixture of water and soap, stabilized by means of a suitable fourth substance. The resulting product, which is of a semi-solid consistency, when properly used, produces a lather which carries away the main portion of the oil. Products of this character combine the detergent action of ordinary soap with the solvent action of the oil. Cup grease, which is one type of lubricating grease, is manufactured by dispersing a calcium or other soap in mineral oil, and adding a small quantity of water which becomes emulsified in the oil. The addition of the water increases the consistency of the product and assists in preventing the separation of the soap in time.

#### EFFECT OF DISTILLATION ON AMORPHOUS WAX

The crystallization of paraffin in petroleum distillates is a subject which has always been of practical importance in petroleum refining. In the manufacture of lubricating oils from distillates containing paraffin wax, it is often customary to redistill the fraction rapidly, utilizing little or no steam, in order to produce a distillate which, when cooled, will precipitate paraffin crystals of sufficient size to permit rapid and efficient pressing, and yielding a "slack wax" which will "sweat" to the best advantage. In the parlance of the industry

this is known as "cracking the wax distillate." One explanation of why "cracking" gives a better wax is that the paraffin hydrocarbons exist as "amorphous wax" and are changed in molecular structure by cracking to "crystalline" wax. The other explanation is that upon "cracking" the viscous liquid components of the oil are altered sufficiently to permit the formation of larger crystals when the distillate is cooled. Experiments by one investigator may be cited in this connection.<sup>12</sup> Natural petrolatum was partly distilled in steam and the distillate and residue examined microscopically. The crystals in the distillate were much more pronounced than in the residue; and when the distillate was melted with the residue it was found that the mixture possessed the same physical properties, and that the appearance of the mass under the microscope was identical with the original product before distillation.<sup>13</sup> The conclusion is drawn that the crystal size is influenced materially by the viscous, non-crystalline components of the oil, and that distilling off part of the oil is equivalent to removal of heavy lubricating oil. If this always is entirely true in regard to the crystallization of paraffin in mineral oil residues and distillates, then the subject is mainly colloidal. Bergel<sup>14</sup> and also Fuchs<sup>15</sup> have carried out investigations which seem to be fair checks of the work of Gurwitsch, although there is still work to be done on this subject. What, for example, will be the comparative crystal sizes of paraffins of different molecular weight in the same heavy oil?

Petrolatum, which is a refined residual from paraffinaceous petroleum, may be defined from the colloidal point of view as being composed of paraffins in dispersed form in a viscous hydrocarbon medium, the latter inhibiting the deposition of paraffin. Artificial petrolatum, manufactured by adding paraffin to heavy oil, often develops a tendency to deposit the paraffin upon standing. Colloidal fuel consists of powdered coal more or less permanently suspended in fuel oil by means of suitable stabilizing agents or "fixateurs," such as soaps or creosote. These products may be prepared of such a consistency that they may be pumped through pipes and burners and may be stored under water. The "germ theory" of lubrication was suggested by Wells and Southcombe<sup>16</sup> to account for the fact that increased efficiency in the lubrication of heavy-duty bearings was attained by adding a small proportion of fatty acid to the oil. One action of the fatty acid was to lower the interfacial tension between the oil and metal, resulting in what might be termed increased oiliness. Since some of the fatty acids are colloidal in mineral oil, the idea suggests itself that other colloidal substances added to the oil may have the same effect. In fact, the relation of colloid chemistry to lubrication offers a field of study in which a solution of many of the abstruse problems may result.<sup>17</sup>

An important application of colloid chemistry to the refining of petroleum distillates is in the use of fullers earth, bauxite, Japanese acid clay and other minerals,

<sup>10</sup>See Gurwitsch's "Wissenschaftliche Grundlagen der Erdöl-bearbeitung," p. 140.

<sup>11</sup>The addition of a lighter oil, such as kerosene or naphtha, has somewhat the same effect as cracking. Cooling the distillate slowly also promotes the formation of larger crystals.

<sup>12</sup>*Petroleum*, vol. 14, p. 173 (1918).

<sup>13</sup>*Petroleum*, vol. 14, p. 1281 (1919).

<sup>14</sup>*J. Soc. Chem. Ind.*, vol. 39, pp. 51, 60T (1920). The small percentage of fatty acid was more efficient than a much larger proportion of fatty oil.

<sup>15</sup>In this connection see Dunstan and Thole, *J. Inst. Pet. Tech.*, vol. 4, p. 191 (1918), and Alexander, *J. Ind. Eng. Chem.*, vol. 12, p. 435 (1920).

<sup>16</sup>See Pickering, *J. Chem. Soc.*, vol. 91, p. 2001 (1907). An important and interesting paper.

<sup>17</sup>Reference is had here to that type of oil soap which contains a large proportion (40 per cent or more) of oil.

bone black, and synthetic products of a siliceous nature, as refining agents by percolation. The principal action is adsorption combined with polymerization". This method of refining offers one of the most promising fields of research at the present time in the direction of search for new and efficient substances, both mineral and synthetic, and their preliminary treatment for the best efficiency in refining. Florida earth has been used more extensively in the past than other fullers earths, but recently new products have been discovered. Death Valley clay, after a special treatment with sulphuric acid, has been found very efficient as a bleaching agent for mineral oils. Some enthusiasts predict that this type of refining agent will eventually replace the use of sulphuric acid."

The examples given above by no means exhaust the possible list of applications of colloid chemistry to petroleum. Other phenomena—in connection with sulphuric acid treatment, plumbite treatment and several phases of large-scale distillation—might be discussed at some length, but the examples already given are sufficient to indicate the importance of the comparatively new science of colloid chemistry to petroleum and its products.

### Edible Oils and Bean Cake in Japan

The Department of Agriculture and Commerce lists 21,304 vegetable oil mills in Japan, employing 28,663 persons. These figures include the vast number of small hand-power mills using primitive crushing methods and scattered through the country districts. Accurate statistics from these mills are practically impossible to obtain. There are about 40 oil mills in Japan of commercial importance. Of these 20 are located in the Kobe consular district. Data concerning the total capacity of the oil mills of Japan are difficult to obtain, owing to their large number and diversity of methods and material, and the further fact that for the smaller mills there are no reliable statistics. The 34 largest mills have a capacity of about 3,570,200 gal. of oil per month. The production of oil for 1918 (the latest figures the Government departments have on the industry), which was a banner year in the industry and the mills were practically working at full capacity, was 547,671 koku (1 koku = 47.6 gal.). The hand mills are operated mainly as side lines during a part of the year by farmers or persons having other occupations. These hand mills consume by far the greater part of the oil-making materials grown in Japan.

The following seeds and nuts are utilized: Rapeseed, perilla, sesame, cotton seed, camellia seed, sasanqua seed, tea seed, wood nuts, kaya nuts, mustard and sumac seeds.

There has been no great increase in the capacity of the plants since that time. The production in 1918 was

Oil	Koku	Oil	Koku
Rape seed.....	150,455	Peanut.....	12,883
Sesame seed.....	18,358	Coconut.....	181,121
Perilla.....	21,514		
Cottonseed.....	16,152	Total.....	547,671
Bean.....	147,188		

It may be noted that the mills as a general thing do not confine their operations to any particular kind of oil, but vary their materials with the demand and the supply of raw materials.

\*Thiele (*Petroleum Age*, vol. 7, No. 9, p. 45 (1920) proposes the use of fullers earth as a cracking agent for petroleum oils.

\*Recent patents propose that gasoline, especially pyrolytic gasoline, be refined by passing the vapors over fullers earth or other substances of like nature.

### Care and Use of the Hygrometer\*

The correct use of the hygrometer is of vital importance in the interpretation and consequent regulation of drier conditions. Altered regulation because of a false conception of the conditions present often results in damage to materials in the chambers or kilns. Several basic practices may be suggested for the proper handling of hygrometers.

#### CONDITIONS UNDER WHICH A HYGROMETER SHOULD BE CALIBRATED

Hygrometers should never be assumed as registering the correct reading until their accuracy has been established.

It is not at all unusual for a thermometer to register a few degrees higher or lower than the true temperature. Each thermometer of a hygrometer should be checked against a standard thermometer of known accuracy over the range of temperature anticipated in its use. Corrections for the several temperatures may thus be determined if inaccuracy exists. Checking should be done with the bulbs of the standard and the tested thermometers close together and in the same medium and temperature of medium. The correction factor for a thermometer at a certain reading being known, it is simple enough to determine the true temperature.

#### FILLING AND CARE

Hygrometer reservoirs should be filled with pure water only. The open-top type of reservoir is easily filled but the inverted-tube type often presents difficulties. The latter type may be filled if submerged horizontally in a pail of water with the water level slightly above the well opening. Other methods of filling such a tube are by means of a wash bottle or small bent-stem funnel. In any case the body should be dropped below the mouth level.

It is important that the silk or muslin covering of the wet bulb be kept in good condition at all times. At least a small amount of solid material is always left in the meshes after evaporation, and sooner or later such a deposit impedes the transference of moisture. It is because of this that pure or distilled water should always be used in the reservoir and that the wick should frequently be changed.

#### PLACING THE HYGROMETER

The hygrometer should be placed at the exact points where information as to conditions is desired. Do not place it near a door or a wall, or where it will be subjected to direct radiation from the heating coils, as conditions at these points are probably not representative. To obtain representative conditions take an average of several readings in different parts of the chamber.

#### TAKING THE READINGS

In reading the wet-bulb thermometer care should be taken that there is sufficient air circulation to give the maximum evaporation rate from the bulb covering. At low temperatures, i.e., up to 120 deg. F., there should be an air velocity of at least fifteen feet per second. At the higher temperatures this rate is not quite so essential. A thorough fanning of the air about the wet bulb is usually required. The lowest wet bulb reading for any air condition is the one desired.

\*From U. S. Forest Product Laboratory Technical Notes.



## Electric Reduction of Iron Ores

### A Discussion of the Comparative Costs for the Commercial Production of Electric Pig Iron in the Shaft and Pit Types of Electric Furnaces and of the Respective Adaptabilities of These Furnaces to Local Conditions

By H. A. DE FRIES

**E**LECTRIC pig iron today is produced commercially in two different ways and in two distinct types of furnaces—i.e., in so-called electric pit furnaces and in electric shaft furnaces of the Electro-Metals type. The latter being the best known, it will be discussed first.

#### REDUCTION OF IRON ORES IN ELECTRIC SHAFT FURNACES

The shaft type of electric furnace resembles in construction the ordinary blast furnace. It is generally designed for three-phase operation with six electrodes, or two-phase Scott connection with eight electrodes. The size mostly in use is three-phase, 3,000 to 4,000 kva., capable of producing from 25 to 30 tons of pig iron per twenty-four hours. The furnace itself and its accessories were fully described by Herlenius in *CHEMICAL & METALLURGICAL ENGINEERING*.<sup>1</sup>

This furnace demands for a charge lump ore, and only a limited amount of fine concentrate may be added in crude form, the maximum being 30 per cent. To use a larger percentage of concentrate it is necessary first to agglomerate it.

The reducing agent most commonly employed is charcoal, which is aided by a constant volume of furnace gas circulated through the furnace. It is therefore obvious that the charge be porous. Coke has been used with varying results.

If we assume that the charge contains 60 per cent Fe, approximately 2,600 kw.-hr. is required for producing one ton of pig. About 500 lb. of lime is added for fluxing and as a reducing agent about 1,000 lb. of charcoal is required. The electrode consumption averages 16 lb.

A complete plant capable of producing 7,500 tons of pig per year will cost about \$150,000. Comparative conversion figures for the production of one ton of pig in this type of furnace are given later.

#### REDUCTION OF IRON ORES IN ELECTRIC PIT FURNACES

As far as the writer is aware, only single-phase and two-phase furnaces of the pit type have produced pig iron commercially. The furnaces have all been constructed on about similar lines and generally consist of a rectangular iron box with open top. This box is lined inside and the hearth is formed by a rammed-in mixture of graphite and tar, which in some instances extends clear to the top. In others the upper part of the furnace is lined with brick. One central electrode of suitable square section serves for the top electrode, whereas the bottom electrode is a graphite block imbedded in the hearth.

These furnaces are generally equipped with one single-phase transformer of from 600 to 1,000 kva. For

larger capacities the two-phase system is used. The low-tension voltage is 50-65-80 volts with full capacity at the lower voltage.

The charge can be either lump ore or all concentrate, or a mixture of the two. Lime is added for fluxing, and charcoal, coke or charcoal mixed with anthracite can be used as reducing agent. The charge is prepared on a platform level with the top of the furnace and is shoveled in continuously. Iron and slag is tapped about every three hours through a common tap hole at the bottom of the hearth. The electrode feed is mechanically regulated by push-button control and as consumed is lowered until its holder is about level with the charge, when a new electrode is inserted. The loss on electrode stumps therefore is low. The furnace itself is cooled on the outside by a waterspray.

The cost of a plant with one 600-kva. unit is about \$25,000, and for each additional unit \$12,000.

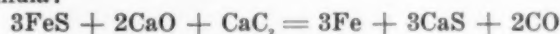
A plant at Porjus, Sweden, is equipped with two single-phase furnaces of this type with 600 kva. each, also one two-phase furnace of 1,800 kva. Here lump ore or concentrate, together with scrap, is used and the average composition of the charge for producing one ton of pig has been as follows:

3,150 lb. of 68 per cent iron ore  
555 lb. of scrap  
145 lb. of lime  
245 lb. of silica  
950 lb. of charcoal  
300 lb. of coke breeze

The 600-kva. furnace produces from this charge an average of six tons of pig iron per twenty-four hours. This pig will average 3½ to 4 per cent C and 2 per cent Si. The kw.-hr. consumption averages 2,800 and the electrode consumption averages 30 lb.

Another interesting example of the application of electric reduction in pit furnaces are the runs made by Guédras & Duina.<sup>2</sup> In this instance pig iron was produced from pyrite cinders. They analyzed about 3 per cent SiO<sub>2</sub>, 94.3 per cent Fe<sub>2</sub>O<sub>3</sub>, 2.8 to 3.5 per cent S and contained about 20 to 22 per cent moisture. The cinders are therefore passed through a rotary drier, which at the same time eliminates most of the sulphur and nodulizes the fine particles. The temperature in this roaster is kept at about 1,000 deg. C. The resulting product contains about 0.1 to 0.2 per cent S. This material is charged into a single-phase furnace of 1,000 kva. with 50-volt, 20,000-amp. low tension.

The furnace is constructed as an open-top furnace, with one carbon upper electrode and a graphitized bottom electrode. Lime is added to the charge and the desulphurizing takes place according to the following formula:



<sup>1</sup>"Swedish Electric Pig-Iron Furnace," *CHEM. & MET. ENG.*, vol. 24, No. 3, Jan. 19, 1921, pp. 108-112. See also Baron Gerard de Geer, "Electric Smelting of Pig Iron at Domnarfvet, Sweden," *CHEM. & MET. ENG.*, vol. 24, No. 10, March 9, 1921, pp. 429-433.

<sup>2</sup>*La Technique Moderne*, July, 1920. See also *CHEM. & MET. ENG.*, Oct. 20, 1920, p. 795.

The carbon necessary for reduction was 450 lb. and can be added in form of coke, charcoal or as a mixture of charcoal and anthracite.

The heat balance sheet as given by Guédras & Duina is interesting:

	Cal.
Reduction of 930 kg. Fe = $930 \times 1887$ .....	1,754,910
Reduction of 10 kg. Si = $10 \times 7,830$ .....	78,300
Reduction of 5 kg. Mn = $5 \times 1730$ .....	8,650
Evaporation of 165 kg. H <sub>2</sub> O = $165 \times 1549$ .....	255,585
Sensible heat in 1,000 kg. iron = $1000 \times 300$ .....	300,000
Sensible heat in 400 kg. slag = $400 \times 500$ .....	200,000
Losses through radiation, gases, conductors .....	259,744
Total .....	2,857,189
Against	
Heat of 212 kg. C = $212 \times 8133$ .....	1,724,916
Heat supplied by electricity .....	1,132,273
Total .....	2,857,189

By analyzing this balance sheet it is seen that the heat of evaporation (1,549 calories) is figured for about 2,000 deg. C.<sup>a</sup> The heat of carbon is calculated, it being entirely burned to CO<sub>2</sub>.

We may roughly reconstruct this heat balance sheet, using Richards' figures, and then would have the following:

Heat distribution:	Cal.
Reduction Fe, $930 \times 1746$ .....	1,623,780
Reduction Si, $10 \times 7000$ .....	70,000
Reduction Mn, $5 \times 1653$ .....	8,265
Evaporation H <sub>2</sub> O, $165 \times 606$ .....	99,073
Sensible heat in iron, $1000 \times 400$ .....	400,000
Sensible heat in slag, $400 \times 600$ .....	240,000
Losses .....	259,744
Total .....	2,700,862
Heat available:	
Assume charge will give up about 410 kg.	Cal.
Oxidation of C to CO = $212 \times 2430$ .....	515,516
Oxidation of CO to CO <sub>2</sub> = $223 \times 2430$ .....	541,890
Heat of slag formation and Fe <sub>2</sub> C, etc. ....	60,000
Heat supplied by electricity .....	1,583,456
Total .....	2,700,862

The first balance sheet shows a requirement of  $1,132,273 \div 846$ , or 1,340 kw.-hr. per 1,000 kg. of pig iron; the second  $1,583,456 \div 846$ , or 1,870 kw.-hr. With single-phase furnaces  $\cos \phi$  is generally 0.7. The actual requirement would, therefore, be 1,900 and 2,670 kw.-hr. respectively. In actual practice an average of 2,200 kw.-hr. per ton was consumed.<sup>4</sup> The resulting pig iron contained from 0.01 to 0.3 per cent S. Electrode consumption was about 30 lb.

In operating electric pit furnaces slag should be based on SiO<sub>2</sub>.2CaO, and if it is necessary to reduce its melting point some Al<sub>2</sub>O<sub>3</sub> is added, the degree then being based on SiO<sub>2</sub>.Al<sub>2</sub>O<sub>3</sub>.2CaO.

#### COMPARISON OF PRODUCTION COST PER TON OF PIG IRON IN SHAFT AND PIT FURNACES

In order to compare the two methods of producing pig iron electrically we will base our estimate on the results obtained abroad, but will modify these to suit American conditions. A comparative conversion table for shaft furnaces as well as pit furnaces will then appear about as shown in Table I.

It will thus be seen that the price of power is the principal item entering into the manufacture of electric pig iron. At today's prices for charcoal iron, about \$25 per hp.-yr. would be the limit for the eastern and central parts of the country. Conditions in the western part, and especially in the Pacific States, however, are much more favorable. From the table it will be seen that the cost of production varies only slightly whether

TABLE I. COMPARISON OF PRODUCTION COST PER TON OF PIG

Assumed: Cost of power, \$25 per hp.-yr. Lump ore or sintered concentrates, \$5 per ton. Crude concentrates, \$4 per ton. Carbon electrodes, \$8 per 100 lb. Lime, \$1.50 per ton. Charcoal, \$12 per ton. Labor, 75c. per hour. 60 per cent Fe in charge. Amortization and interest spread over ten years.

Electric Shaft Furnace, 3,000 kva.	Pit Furnace, Single Phase, 600 kva.
Power, 2,600 kw.-hr. ....	2,800 kw.-hr. ....
Ore, 3,300 lb. @ \$5. ....	3,300 lb. @ \$4. ....
Charcoal, 1,000 lb. ....	1,200 lb. ....
Electrodes, 15 lb. ....	30 lb. ....
Lime, 500 lb. ....	200 lb. ....
Labor, operation. ....	Operation. ....
Repair gang. ....	
Furnace repair. ....	
Miscellaneous power for auxiliaries, etc. ....	
Amortization and interest. ....	
Total, per ton of pig. ....	
Yearly production per furnace 7,500 tons	2,000 tons
Plant investment. ....	
Plant investment per year ton of pig. ....	

\*3,000-kva. furnaces supply enough gas to fire one 10 to 15-ton open hearth; value of this gas is, therefore, about \$1 per ton of pig produced, so that the above net cost is \$31.42.

the iron is produced in a shaft furnace or a pit furnace. The difference in plant investment, however, is considerable, even if it takes three single-phase furnaces to equal the output of one shaft furnace. The cost of the shaft-furnace plant was given at \$150,000, whereas a plant with three pit furnaces would cost only \$50,000, or one-third. The labor cost may seem high for a one-unit pit furnace plant, but with three of these furnaces installed under the same roof it will approach the labor cost given for the shaft furnace. From a central station point of view, the shaft furnace will be more acceptable than the single-phase furnace and most power companies may object to a large single-phase load. This objectionable feature could be somewhat remedied by installing two or three furnaces on the same line.

However, the main advantage the pit furnace has over the shaft type is its adaptability to all kinds of ores, whether lump or concentrates, or both mixed.

This feature may be of utmost importance for working magnetite and other concentrates direct without previous sintering, and a possibility may exist even of reducing in them the concentrates from the black sands which are found so abundantly on the shores of the Pacific States. These sands as a rule carry considerable TiO<sub>2</sub>. How far this can be removed by concentration or what influence it has during reduction the writer is unable to state. I believe, however, that 2 per cent TiO<sub>2</sub> in the concentrates would have little influence in the operation. It would be worth while to experiment with them in a small unit of, say, 150 kva. If such experiments should prove successful, they not only would make available a considerable new supply of iron, but there may also exist the possibility of retaining some of the Ti in the pig, which may make it more valuable for certain purposes.

#### ADAPTABILITY OF SHAFT AND PIT TYPES OF ELECTRIC FURNACES

In the production of electric pig iron, we have to consider two alternates:

First, if lumpy ore and sintered concentrates are available, a large unit plant is desired, the demands of the central station are strict and capital expenditure is of secondary nature, the electric shaft furnace should be employed.

On the other hand, if only crude concentrates are available, or the plant depends on a varying ore supply, no objections being raised against single-phase loads, and capital expenditure has to be limited, then the pit furnaces apparently possess considerable advantages over the shaft type.

<sup>a</sup>Heat content of H<sub>2</sub>O vapor at 2,000 deg. C.

<sup>4</sup>As Richards has stated: "In properly designed furnaces the gases passing out may contain nearly equal volumes of CO and CO<sub>2</sub>, instead of as shown. Any greater utilization of the heat-producing power of the carbon will naturally decrease the electrical energy required." This evidently is the fact with the pit furnace.



## Hardwood-Distillation Industry—II

### Influence of Temperature and Speed of Distillation on the Amount and Nature of the Distillates, With a Brief Review of the Crude Products Obtained by the Destructive Distillation of Wood\*

By L. F. HAWLEY†

ONE of the first questions to be asked in connection with wood-distillation is naturally in regard to the temperature at which wood begins to distill. This, unfortunately, is a subject on which much misinformation is still in circulation, owing largely to the fact that certain figures published nearly seventy years ago have been copied and recopied from one book to another until the original article has been lost track of and the methods used in obtaining the figures have been forgotten. Most articles on wood-distillation include tables showing the loss in weight of wood when heated to different temperatures. These tables are usually ascribed to Violette, but the original article is never cited and the method by which Violette obtained his figures is never described. Violette's table shows that there is a gradual increase in the loss in weight of wood with increase in temperature to which it is subjected. The point at which the drying of the wood ceases and the destructive distillation begins being arbitrarily taken as 150 deg. C., there is no break in the curve except a very slight one at about 260 deg. C. Although information has been available for some time to show that these figures are wrong, yet each new book or article on wood-distillation includes Violette's original table as showing the effect of temperature on wood.

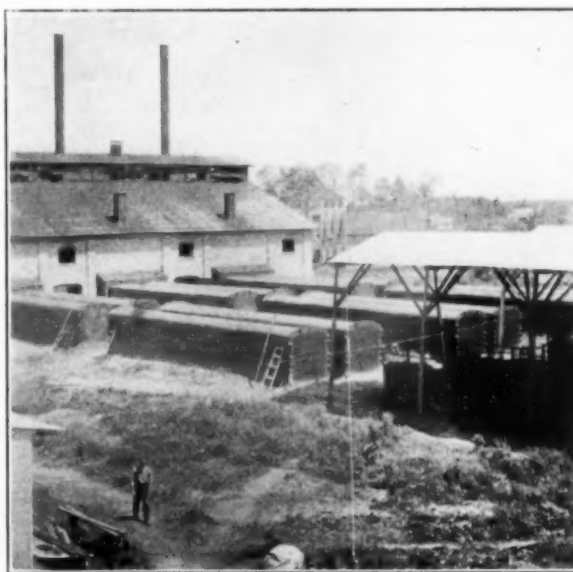
#### RELATION BETWEEN TEMPERATURE AND DECOMPOSITION OF WOOD SUBSTANCE

Probably the first correct figures published on the relation between temperature and decomposition of wood substance were by Chorley and Ramsay.<sup>1</sup> These results indicated that there was very slight decomposition of wood below a temperature of about 270 deg. C., but that at this point the decomposition was very rapid and in fact the reaction became exothermic. These figures remained unnoticed for some time; but in 1907 Klason<sup>2</sup> and his co-workers repeated the experiments more accurately and in more detail, showing definitely the exothermic reaction and computing the amount of heat given off by this reaction.

In the case of an exothermic reaction such as this, it would not be possible to obtain a gradual decomposition with increase in temperature, as shown by Violette, since the decomposition would become very rapid at about 270 deg. C. In an endeavor to explain this discrepancy the original article<sup>3</sup> was consulted and a satisfactory explanation obtained. The figures re-

ported by him were obtained with wood in very small cylindrical blocks about  $\frac{1}{2} \times 1\frac{1}{2}$  in. heated by a rapid current of superheated steam in direct contact with the wood, and the temperatures measured at the outlet from the retort. Experiments in distilling wood in a vacuum have shown that no exothermic heat is noticed under these conditions, and as the rapid passage of a current of superheated steam has exactly the same effect as a vacuum distillation, in so far as the rapid removal of the products from the retort is concerned, no exothermic reaction should be expected under conditions such as were present during Violette's distillations. It is hoped that Violette's figures will not be quoted again as representing the effect of temperature on wood as ordinarily heated, but that the correct and recent figures of Klason may be used instead.

There is, of course, a certain amount of decomposition of wood below 270 deg. C., but this is very slow



RETORT HOUSE, COOLERS AND CHARCOAL SHEDS  
AT PLANT OF THE CLIFFS CHEMICAL CO.,  
GOODMAN, WIS.

and the products given off are mostly carbon dioxide and water. At about 270 the exothermic reaction begins and the decomposition of wood into its ordinary distillation products is completed without further addition of heat. If the residual charcoal is heated to still higher temperatures it comes nearer and nearer to being pure carbon; but the volatile products given off are mostly tar and gas, and only traces of methanol and acetic acid are obtained.

Klason, who made the first measurements of the heat of the exothermic reaction, has also offered the first partial explanation of the heat given off at this

\*For Part I see CHEM. & MET. ENG., vol. 25, No. 4, July 27, 1921, pp. 137 to 140.

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<sup>1</sup>J. Soc. Chem. Ind., vol. 11, p. 395 (1892).

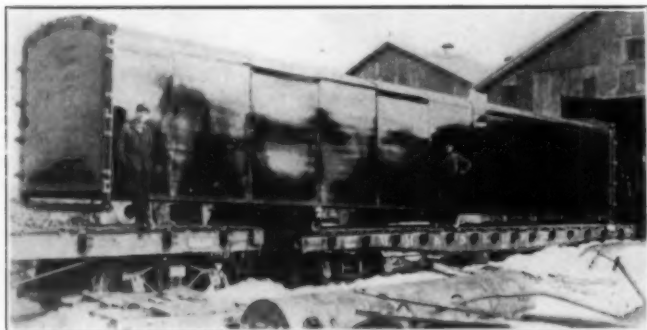
<sup>2</sup>"Arkiv för Kemi, Mineralogi och Geologi, 1907," Z. angew. Chemie, vol. 25, p. 1205 (1909), and vol. 27, p. 1252 (1910).

<sup>3</sup>Ann. chim. phys. 3me serie, vol. 32, p. 304 (1853), and vol. 39, p. 291 (1855).

period.<sup>1</sup> By distilling wood under very low pressure and at a carefully regulated temperature, it was found possible to complete the distillation without obtaining an exothermic reaction. The products of this slow decomposition were, however, different from the original products, in that over 40 per cent of the weight consisted of a transparent red oil and much less gas and charcoal than usual were formed. This red oil when heated to about 275 deg. C. decomposed exothermically, forming considerable quantities of gas, water, a black tar similar to ordinary hardwood tar, and coke. This indicates that the first decomposition of wood by heat is not exothermic, but that some of the primary products of the distillation decompose exothermically. In any kind of practical process, however, this distinction between primary and secondary reactions is not applicable, and it may be correctly considered that wood-distillation is an exothermic reaction.

#### TEMPERATURE CONTROL

Temperature control, as a means of increasing the yields of methanol and acid, has always been a subject of great interest in the wood-distillation industry. Many



STANDARD CHARCOAL COOLERS

years ago Senfft<sup>2</sup> published some figures which showed the effect of charging the wood into a red-hot retort as compared with starting from a cold retort. In nearly all cases the distillation in the red-hot retort resulted in a higher yield of gas and a lower yield of charcoal, tar and acid. Unfortunately the methanol determinations were not made in this study. It has been a general opinion among the distillation-plant operators that considerably higher yields could be obtained by a long, slow distillation of thirty-six hours than by the ordinary twenty-four-hour period.

Palmer's work on temperature control<sup>3</sup> showed that it was possible to increase the yields of both acid and methanol by a careful regulation of the firing of the retorts, which was accomplished by watching the temperature of the vapors coming from the retort and the composition of the distillate as noticed at the mouth of the condenser. By heating rapidly at the beginning of the distillation and then checking the fire at just the right time, so as not to have the temperature carried too high by the exothermic reaction, he found it possible to complete the distillation in the usual period and still obtain an increase in yields. This seemed to check the prevailing opinion that slow distillations gave high yields and fast distillation low yields.

This opinion is undoubtedly correct under the conditions of large-scale distillations and considerable

super-heating of the walls of the retort. It has been shown, however, by Klason in the article previously mentioned, that this opinion is not correct in connection with small-scale distillations. Klason distilled wood in small glass apparatus under conditions varying from a 3-hour distillation under the highest possible vacuum to a 14-day distillation at ordinary pressures. From the results of this series of distillations it was possible to decide with considerable accuracy which products were primary products of the first decomposition of the wood by heat and which were secondary products obtained by decomposition or interaction of the primary products. It was found that methanol and acetic acid were both primary products and that their yields did not vary appreciably when varying the conditions of distillation. The speed of distillation, therefore, has no effect on the yields of methanol and acetic acid.

#### DISTINCTION BETWEEN EXPERIMENTAL AND COMMERCIAL DISTILLATION PRACTICE

At first glance it may seem difficult to harmonize Klason's results with the opinion commonly held in commercial operations, that high speed of distillation gives low yields of methanol and acid. We believe, however, that these apparently opposite views can be reconciled. The experimental work of Klason was carried out in very small-scale apparatus, only about 9 g. of wood being used in some of the experiments. In a case like this, rapid distillation, such as a complete distillation in three to four hours, can be obtained without any very great superheating of the walls of the containing vessels—that is, the walls of the vessel may have been only 5 to 10 deg. higher than the reaction temperature, a difference which is not sufficient to produce secondary reactions. In commercial practice, on the other hand, the cross-section of the distillation vessel is very large, and in order to finish a distillation even in twenty-four hours it is necessary that the walls of the retort during much of the distillation be heated 100 or 200 deg. higher than the reaction temperature. This means that, in commercial apparatus, high speed of distillation is obtained only by greatly increased temperature of the walls of the retort and the superheating of the walls of the retort is sufficient to produce secondary reactions.

#### INFLUENCE OF THE SPEED OF DISTILLATION

Klason found that slow distillation produced more secondary reactions, since the vapors remained in the retort for a greater length of time than they do in rapid distillation. In this case the slight increase in temperature of the containing vessel in order to obtain rapid distillation does not have so much effect on the secondary reactions as the length of time which the vapors remain in the retort. He also showed that within certain limits and certain conditions of distillation it is impossible to vary the yields of methanol and acid appreciably by variation of the speed of the reaction or the pressure at which it is carried on. This does not mean, however, that there is not still a chance to obtain increased yields in commercial practice by temperature control, since present commercial plants obtain only about two-thirds of the acetic acid which can be obtained in medium-sized apparatus. Many carefully managed commercial plants obtain the apparent full yields of methanol, so that temperature control does not offer much in connection with this product.

<sup>1</sup>J. Prakt. Chem. (2), vol. 90, p. 413 (1914).

<sup>2</sup>Ber., vol. 18, p. 60.

<sup>3</sup>J. Ind. Eng. Chem., vol. 7, p. 633 (1915).



It has been frequently noticed that wood continuously subjected to medium-high temperatures, such as the temperatures of steam pipes containing steam under low pressure, will slowly darken and finally become a true charcoal. A commercial process was at one time developed for obtaining acetic acid from wood at temperatures below the exothermic reaction; but this was a very slow process requiring careful temperature control, and besides it gave different proportions of methanol and tar. It is apparently possible, therefore, to obtain the effects of high temperature on wood by long subjecting to lower temperatures; but this is of no importance in connection with commercial wood-distillation, which must be completed within a practical time limit.

#### CRUDE PRODUCTS OF THE DESTRUCTIVE DISTILLATION OF WOOD

From what has been said previously in regard to the complexity of the composition of wood and the character of the decomposition which takes place with heat, it might be expected that the chemical reaction of the decomposition would be very complex and that the products would be numerous. This supposition is correct as regards the various chemical constituents of the products, but the crude products as described in the terms used in the industry are not numerous and the general conception of the chemical composition of these crude products is not very complex. The crude products are: charcoal, vapors (pyroligneous acid and tar) and gas.

#### CHARCOAL

The charcoal which is left behind in the retort is usually thought of as carbon, and since this charcoal is a finished commercial product, its chemical composition is not considered important. It may be considered as being a very complex hydrocarbon, varying in composition between the extremes of wood on one hand and pure carbon on the other, depending on the temperature to which it has been heated. The commercial product usually still contains as high as 25 per cent of volatile matter. A new conception of ordinary charcoal is given by Klason, who considers it as consisting of a primary charcoal plus a secondary deposit of tar coke.

The charcoal as drawn from the retorts needs only to be cooled in order to render it safe for shipment or storage as a marketable product. In ordinary commercial practice it is cooled for forty-eight hours in coolers and then left for twenty-four hours in the open air.

Even with this cooling and air-seasoning, spontaneous combustion will sometimes take place in the charcoal. It is quite certain that this combustion is not caused by incomplete cooling or by sparks or brands which remain in the coal but by incomplete saturation of the charcoal with the gases of the air, so that with further absorption of these gases comes a slight increase in temperature, which in large amounts of charcoal may be sufficient to start combustion. The detailed mechanism of this spontaneous combustion has not been worked out and no clear theory has been developed.

#### CRUDE VAPORS (PYROLIGNEOUS ACID AND TAR)

The chemically valuable products of wood-distillation are contained in the crude vapors which after condensation separate into two layers: tar underneath and crude pyroligneous acid on top. Gravity and solubility are not sufficient for the complete separation of these two products, and some of the constituents of the tar are found in the pyroligneous acid and *vice versa*. Their

complete separation can be realized by fractional distillations.

The pyroligneous acid consists largely of water, but methanol, acetic acid and dissolved tar are also among the main constituents. The presence of acetic acid and methanol seems to make certain constituents of tar soluble in pyroligneous acid which are not soluble in pure water. The tar which is soluble in pyroligneous acid has a very different composition from the insoluble tar and consists largely of a non-volatile pitch containing only a small amount of oil. Many of the tar constituents, especially the acids and esters, are also present in the pyroligneous acid.

There are many other products occurring in the pyroligneous acid in small amounts which have not been identified and which are recognized only by their effect on the refining process. For instance, when the pyroligneous acid is distilled in order to separate it from the dissolved tar, it is obtained as a light-colored liquid which, having just been distilled, must contain only volatile products. Yet when the distilled pyroligneous acid is neutralized with lime and the solution evaporated, considerable amounts of non-volatile tarry material are left behind with the acetate of lime. This tarry impurity in the acetate of lime must come from



CHARCOAL GOING FROM FIRST TO SECOND COOLER

volatile constituents of the pyroligneous acid which have been decomposed or polymerized by the addition of lime. Small quantities of oils also remain dissolved in the pyroligneous acid until it has been neutralized and distilled. These oils have been separated out from the distillate and at some plants are known as primary oils or lime-lee oils. They are the most valuable raw material for making beechwood creosote.

The tar obtained in the distillation of hardwood was used as fuel without further treatment until a few years ago; but now it is common practice to distill it with steam in order to remove the acid and methanol contained in it. This process has been fully discussed in a recent publication.<sup>10</sup>

The separation of the chemically valuable products from pyroligneous acid and tar will be discussed in a subsequent issue.

#### WOOD GAS

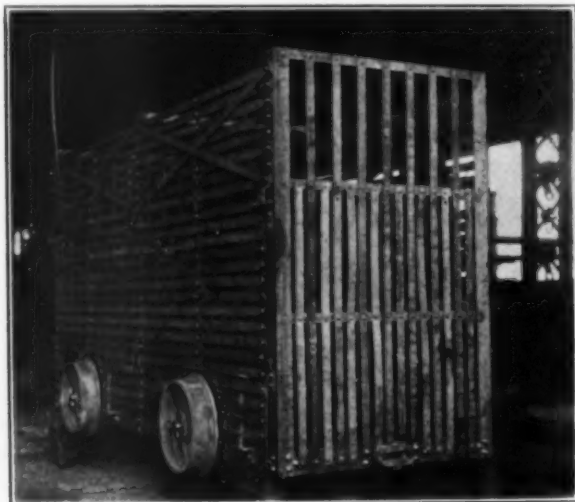
The gas which is formed during the distillation of the wood has a low heating power and is ordinarily used for

<sup>10</sup>J. Ind. Eng. Chem., vol. 12, p. 684 (1920).

fuel at the plant. It contains large quantities of carbon dioxide, which accounts largely for its low heating power. Carbon monoxide and methane are the main combustible constituents, and it seems very likely that other gases which have been found in small quantities, such as hydrogen and ethylene, are obtained only as secondary products when the temperature of distillation is very high.

It has long been recognized that certain valuable products are lost in the wood gas which passes from the condensers, but there seems to be some general misunderstanding in regard to what these products may be, in what form they are lost, and by what process they may be recovered.

The first source of loss at this point is the mechanical carrying over of drops of liquid in the form of a fog or mist. This is not caused by incomplete cooling, since the fog will persist even when the condensers are working properly and the gas is well cooled. Apparently the loss in the form of fog cannot be avoided where considerable quantities of non-condensable gas pass through the condensers. The other source of loss in the gas is the vaporizing of the low-boiling constituents, which



24-CORD CHARCOAL BUGGY

will be carried off in the gas to some extent, however low the temperature of the condenser may be. The amount of the various liquid constituents therein will depend on their volatility and on the relation between the amounts of gas and volatile liquid. That is, as might be expected, the most volatile constituents are the ones which are lost in greatest proportions, and since they are among the most valuable constituents in wood-distillation, the loss from this source may be of serious consequence. Methanol, methyl acetate and acetone will be the main products lost in this way, since they not only have low boiling points but also form constant boiling mixtures with lower boiling points than the pure products themselves.

#### USE OF THE COTTRELL PRECIPITATOR FOR THE SEPARATION OF THE FOG IN WOOD GAS

The loss due to mechanically carried over drops of liquid in the form of a fog or mist can be partly stopped by the use of gas scrubbers in which the gas is subjected to the action of a liquid such as water. Washing a gas with water may still leave a part of this fog unprecipitated, and the best method for stopping such losses is by means of the Cottrell precipitator.

An unpublished report by the Research Corporation shows that a Cottrell precipitator on the gas line beyond the condenser will completely stop this fog, with the recovery of the products otherwise lost in this form. The amount of the material precipitated by the Cottrell process amounts to only about 1.7 per cent of the total distillate obtained at the condenser, and the proportion of valuable products in the recovered fog is slightly different from that in the condensate. The proportion of tar to pyroligneous acid is about the same, but there is a little less methanol in the pyroligneous acid from the precipitator than in that from the condenser.

During the period of high prices of acetate and methanol a few years ago it would have apparently been a profitable investment to install a Cottrell precipitator for the recovery of this material, but at present price it would not be a favorable investment.

#### USE OF SCRUBBERS FOR THE RECOVERY OF THE LOW BOILING CONSTITUENTS CARRIED OFF BY THE WOOD GAS

The loss of the vapors of low-boiling constituents carried off by the wood gas can be controlled to a certain extent by a lower temperature of the condenser water, but there is a limit to the recovery by this method. The only other method is a treatment of the gas with some liquid in which the volatile products are soluble and which will reduce their vapor pressure. Water would naturally be the scrubbing liquid to be used, since it is convenient and the volatile products are soluble in it.

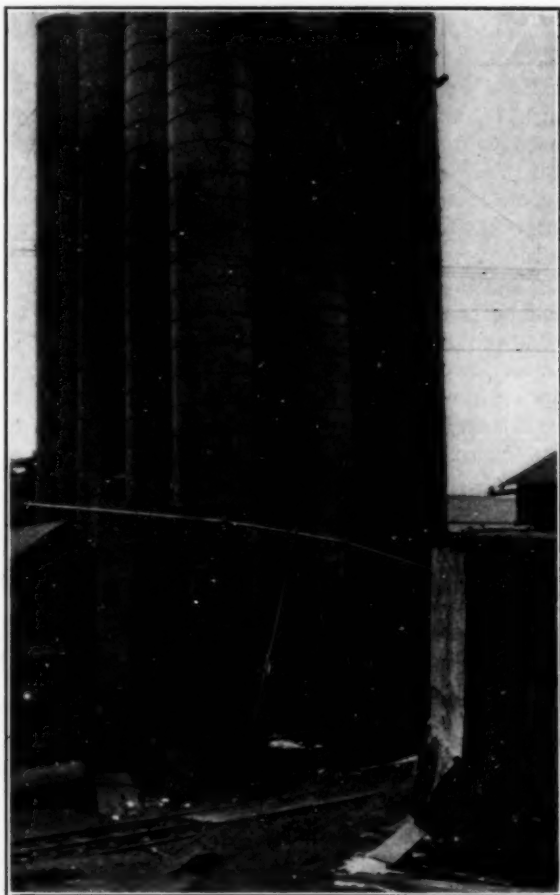
The amount of the products which can be recovered by scrubbing with water depends upon the amount of water and the efficiency with which it is used. With large amounts of water, with complete contact between the water and the gas, and with the water and gas moving in opposite directions, it is possible to make a practically complete recovery of the vaporized products in the gas. There is a limit, however, below which the complete recovery would be impractical, since too large amounts of water would be required and the recovery from the water would be too expensive.

The kiln plants at one time in common use in northern Michigan and Wisconsin had a much larger proportion of gas than the retort plants, since large amounts of air were admitted to the kiln during the burning process. The residual nitrogen of the air and the products of combustion are, therefore, added to the normal amount of gas obtained from the distillation of the wood. Most of these kiln plants had some sort of gas-scrubbing apparatus, but it was usually small in size, and frequently pyroligneous acid was used for the scrubbing material instead of pure water. This was wrong in theory, since the gas was being washed by some of the liquid with which it was already in equilibrium, and it could not be expected that any more of the vapors in the gas could be removed by means of the liquid with which the gas had just been in contact. In some cases the first fraction from the central condensing system was used for the scrubber, and this naturally held somewhat less of the low-boiling constituents than the last fractions. This was a step in the right direction, but pure water would have been much better.

We do not know of any place where scrubbers are now used in retort or oven plants, but some interesting applications of this principle have recently been made at some of the old kiln plants. Special scrubbing towers with fresh water as scrubbing material have been



installed, and liberal amounts of water have been used to wash the gas. It is claimed that increased yields of methanol amounting to as much as 3 gal. per cord have been obtained by the use of these tower scrubbers. This is not all pure gain, since the liquor from the scrubbers contains only a small percentage of methanol, and large amounts of liquor must be handled in order to secure this increased yield. By means of a special still it is possible to recover that liquor in partly concen-



GAS-SCRUBBING TOWERS BUILT OF WOOD STAVE-PIPE, FILLED WITH BRUSH PACKING

trated form without actually distilling a very large portion of the scrubber liquors, and at small cost.

In view of these increased yields obtained with a gas scrubber at a kiln plant, it seems as if similar results might be obtained by applying this principle to the modern oven plants. Although there is a higher proportion of gas from the kiln plant, yet the concentration of the more volatile products is greater in the liquor from the oven plant, and the proportion of the total product lost in the gas might be as great in the latter as in the former. The application of this principle is, however, much simpler in the kiln plant, since here a central condenser system is used and all the gases are naturally collected at one place.

It has been reported that gas scrubbers have been used at oven plants, but that explosions occurred in them, and they were finally given up. There is, of course, danger of explosion with gas scrubbers when air is allowed to mix with the gas in proper proportions to form an explosive mixture, but ordinary care in the design and operation of the apparatus should obviate this danger.

*Part III will be published in a subsequent issue.*

### Antimony in 1920

Except for the antimony in hard lead, no antimony has been produced in the United States from domestic ores since 1918, according to Frank C. Schrader, United States Geological Survey. This situation, however, is not considered altogether unfortunate, as our meager supply of ore may thus be kept for a time when we will need it, perhaps as urgently as we did during the World War.

Hard lead carrying about 14 per cent of antimony is a byproduct of the smelting of the precious metals, and the quantity of hard lead produced in 1920, which was 12,535 short tons, carried 2,033 tons of antimony and was obtained from both domestic and foreign ores. A small quantity of metallic antimony was produced by one smelter from both foreign and domestic ores, and about 5,000 tons of secondary antimony was recovered from old alloys, scrap, and dross.

The average price of antimony in 1920 was 8.49c. a pound. The highest price, which was reached in February and March, was 11½c., but owing to large imports and heavy offerings of war scrap and shrapnel by several governments, the price fell in December to 5½c., the lowest in more than six years.

The imports for consumption, calculated in terms of metallic antimony, were 11,768 short tons, as compared with 7,867 tons in 1919. Their value was \$1,435 823. They consisted of 1,709 tons of 40 per cent ore, 1,375 tons of 75 per cent matte, 9,817 tons of metallic antimony, and 298 tons of 80 per cent antimony oxides and other compounds.

The general imports were 12,474 tons of antimony and 1,709 tons of ore containing 682 tons of antimony. They showed an increase of about 76 per cent as compared with those of 1919. The metal came mostly from China and Japan and the ore from China, France and Bolivia. The imports of metal from China increased 175 per cent over those of 1919.

The imports of type metal were 14,944 short tons, or more than twice those of 1919. Their antimony content was assumed to be 2,063 tons, or about 14 per cent.

The exports of foreign antimony from the United States in 1920, mainly to Canada, amounted to 448 tons, more than double those of 1919.

About 1,877 short tons of antimony was in bond in December, 1920, as compared with 1,200 tons for December, 1919.

The world's production of antimony in 1920 was about 14,000 metric tons, as compared with 11,900 tons in 1919. Nearly all of it was produced in China, Mexico, and France. For several years China has produced more than 60 per cent of the world's supply.

The world's average annual peace-time consumption of antimony, not including that in antimonial lead, is about 22,000 metric tons, of which the United States consumes 7,000 tons. The United States also uses annually about 2,100 tons of virgin antimony contained in domestic antimonial lead and 3,500 tons of secondary antimony recovered from old alloys, scrap, and dross, a total of 12,600 tons.

Metallic antimony is used chiefly in alloys, such as type metal, Babbitt or bearing metal, Britannia or white metal, and antimonial or hard lead. Antimony oxides are used for making white enamel, and both oxides and sulphides are used as coloring agents and pigments.

A copy of the report may be obtained from the Director of the U. S. Geological Survey, Washington, D. C.

## Heat Balance of a Blast-Furnace Stove

Careful Tests by Improved Methods of a Two-Pass Side Combustion Stove at the Lackawanna Steel Co.  
—Net Efficiency Found to Be 62 Per Cent—Volume of Blast Computed From Carbon  
Balance, and Volume of Gas From Its Analysis, Fresh and Diluted

BY D. W. WILSON\*

IN THE first full year, 1920, of its operation, the School of Chemical Engineering Practice of the Massachusetts Institute of Technology has located one of its industrial stations in Buffalo at the plants of the Larkin Co. and the Lackawanna Steel Co. The experimental work forming the basis for this article was performed at the latter plant by the students enrolled in this course during 1920. Three separate tests, the last of which is given in detail here, were carried out by as many groups of students on the same blast-furnace stove, but under slightly varying conditions. The interest and enthusiasm of all the students in this work was very inspiring, and it is desired to acknowledge here the able assistance rendered by A. J. Hartsook, L. Weinberg and H. R. Couch, leaders respectively of the first, second and third groups of students performing this test.

### PURPOSE OF THE TESTS

Necessarily, in this work the purpose was twofold: (1) From the students' point of view to illustrate the practical use of thermocouples and other temperature-measuring devices, as well as methods for measuring gas volumes under somewhat unusual conditions, and, further, to show the method of calculating the data obtained in this way to indicate the heat efficiency of a large gas-fired furnace; (2) from the technical standpoint—that is, the value of the results of the experimental work in and of themselves—the endeavor was made to carry out a complete and careful heat balance on a modern, well-designed blast-furnace stove, and inasmuch as tests had not previously been carried out on this installation, figures showing the utilization of heat are of considerable interest, since by comparison with other stoves of the same type it is possible to determine the relative efficiency of design, construction and operation.

### TYPE OF STOVE AND ACCESSORIES

The stove itself consists of a vertical cylindrical steel shell lined with firebrick, 22 ft. in diameter by 110 ft. in height. Inside the firebrick lining it is divided into two vertical parts, one elliptical in cross-section and extending the entire height of the stove, through which space the gas is burned for heating, and the other, also running the entire height and occupying the remainder of the space, filled with firebrick laid so as to give a large number of parallel flues through which the gas must pass. This is the so-called two-pass side-combustion stove. It is equipped with two chimney valves, only one of which was in use. Gas passes through a suitable burner into the elliptical space, burns up

through it, and the burned gas passes down through the parallel flues and out to the stack, while in heating the air blast the flow of air is counter-current. The operation is necessarily an intermittent one in which the time ratio of heating and cooling a given stove is three to one, since four stoves are in use.

The gas used in this installation was cooled and cleaned before burning by a system of dry dust catchers followed by scrubbing with water. Natural draft only was used in the combustion of the gas and in taking care of the burned gases. The stove was in excellent condition, it having been in constant operation on clean gas about three years.

### DESIGN OF TESTS

The tests, consisting as they did of balancing heat input against heat output, involved primarily a knowledge of the quantity of gas supplied per unit time to the stove; the analysis, calorific value and temperature of this gas; amount, temperature and moisture content of the air used for combustion; temperature and analysis of stack gas; and quantity, moisture content and temperature of air in the blast heated by passage through the stove. Details of this and other needed information may be obtained from the tables.

A suitable method of measuring the volume of blast-furnace gas passing to the stove was necessary, and was not at once apparent, since the amount of moisture and dirt in the gas was sufficient to make the use of the Pitot tube very difficult. The scheme finally adopted consisted in diluting the gas some distance back from the point of its entrance to the stove with a measured volume of air and analyzing the gas before adding the air and again after the gas and air were thoroughly mixed. Air for this purpose was measured by an orifice and delivered into the gas main by a small pressure blower. To obtain results of the needed accuracy required careful gas analyses, which, with care, however, was entirely within the range of practical possibilities. Table I contains the experimental data obtained in this way.

Another problem consisted in the estimation of the volume of air delivered to the blast furnace. This is extremely important, since the heat efficiency of the stove is based upon an exact knowledge of it. A method often depended upon and which was used in this work as a check only consists in estimating the volume from the size of cylinder, length of stroke, speed and slippage of the blowing engines.

In this test the air volume delivered by the stove was determined by analyzing all carbon-bearing materials entering and leaving the blast furnace. This information, coupled with a knowledge of the quantities of these various materials entering or leaving the

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furnace over a given period of time, is sufficient to render possible the calculation of the air volume per unit time.

In Table I are included all the experimental measurements taken, upon which were calculated the data shown in Table II and III.

TABLE I. EXPERIMENTAL DATA

Date of test, Dec. 2-3, 1920.		
Size of stove, 22 x 110 ft.		
Size of combustion chamber (cross-section) 4 ft. 11 in. x 11 ft. 9 in.		
Length of time in service, 3 years.		
Checker opening, 5 1/2 in.		
Duration of cycle (returning to initial temperature).		
Starting temperature, 770 deg. C.		
Cycle 1—From 3:34 p.m. Dec. 2 to 1:14 a.m. Dec. 3. On gas 3:40 p.m. to 10:40 p.m. (Blast off 3.5 min.) On air 10:45 p.m. to 1:07 a.m. (Blast off 74 min.) Time extended 7 min. beyond 1:07 a.m. to allow time for stove to reach temp. of 770 deg. C.		
Cycle 2—From 1:14 a.m. Dec. 3 to 10:29 a.m. Dec. 3. On gas 1:12 a.m. to 7:55 a.m. (Blast off 23.5 min.) On air 8:00 a.m. to 10:25 a.m. (Blast off 17.5 min.) Time extended 4 min. beyond 10:25 to allow time for stove to cool to 770 deg. C.		
Net time on gas (No. 1 cycle), 416.5 min.		
Net time on air (No. 1 cycle), 141.75 min.		
Net time on gas (No. 2 cycle), 379.5 min.		
Net time on air (No. 2 cycle), 131.5 min.		
Pressures: (In inches of water unless otherwise stated):		
Blast-furnace gas in main (No. 1 cycle).....	8	
Blast-furnace gas in main (No. 2 cycle).....	8	
Air for dilution (in line to orifice).....	27	
Orifice differential.....	12	
Air blast, lb. per sq.in., avg. (No. 1 cycle).....	17.8	
(No. 2 cycle).....	21.4	
Barometer, lb. per sq.in. ....	14.8	
Size of orifice for air.....	3.1 in.	
Temperatures, Deg. F.:		
Blast-furnace gas in main, avg. (No. 1 cycle).....	58	
(No. 2 cycle).....	54.6	
Air through orifice (avg. for two cycles).....	37.0	
Cold air blast (No. 1 cycle), avg. ....	150	
(No. 2 cycle), avg. ....	162	
Hot air blast (No. 1 cycle), avg. ....	1,645	
Leaving stove (No. 2 cycle), avg. ....	1,543	
Flue gas to stack (No. 1 cycle), avg. ....	426	
(No. 2 cycle), avg. ....	406	
Hot air blast (bustle pipe), avg. ....	1,196	
Atmospheric Conditions, Deg. F.:		
Wet bulb.....	34.6	
Dry bulb.....	37.2	
Wet bulb at blowing engines, during pumping (avg.)....	36.0	
Dry bulb at blowing engines, during pumping (avg.)....	39.5	
Gas Analyses:		
Blast-furnace gas, 12-in. orifice differential before adding air (avg.):		Per Cent
CO <sub>2</sub> .....	14.5	
O <sub>2</sub> .....	0.1	
H <sub>2</sub> .....	3.5	
CO.....	24.1	
CO + H <sub>2</sub> .....	27.6	
After adding air (avg.):		
H <sub>2</sub> .....	2.6	
CO.....	22.8	
CO + H <sub>2</sub> .....	25.4	
Flue gas (avg.):		
CO <sub>2</sub> .....	19.3	
O <sub>2</sub> .....	1.9	
N <sub>2</sub> .....	78.8	
Carbon Balance:		
Carbon input, 9:17 a.m. to 9 p.m. Dec. 2 (703 min.):		
Coke:		
Total weight charged, lb. 581,000.		
Per cent carbon, 83.8.		
Scrap:		
Total weight charged, lb. 56,000.		
Per cent carbon, 4.0.		
Limestone:		
Total weight charged, lb. 264,000.		
Per cent carbon (95 per cent CaCO <sub>3</sub> ) 11.4.		
Carbon Output:		
Flue Dust:		
Weight per day (estimated), lb. 70,000.		
Per cent carbon, 7.14.		
Pig Iron (duration of test):		
Weight, lb. 1,047,000.		
Per cent carbon (estimated) 3.75.		
Blowing Engines:		
R.p.m., 61.2. Number of compressions per revolution, 2.		
Diameter of piston, 84 in.		
Diameter of piston rod, 16 in.		
Length of stroke, 60 in.		
Slippage (measured), 5 per cent.		
Radiation Data:		
Average skin temperature, combustion side of stove, 161 deg. F.		
Average skin temperature, flue side of stove, 108 deg. F.		
Temperature of surrounding air, 37 deg. F.		
Area of combustion side of stove, 1,990 sq.ft.		
Area of flue side of stove, 5,660 sq.ft.		
Average skin temperature of hot blast main, 90 deg. F.		
Area of exposed surface of hot blast main, 1,980 sq.ft.		

This test extended over two complete cycles—that is, two periods during which gas was burned in the stove

to heat it up, and subsequently air passed through it to be heated before its entrance to the blast furnace. An arbitrary point of 770 deg. C. was chosen as the starting point, and therefore the length of cycle is corrected to allow for the return of the stove to the initial temperature. A constant differential pressure of 12 in. was maintained at the orifice measuring the air used to dilute the blast-furnace gas. This was kept constant by proper regulation of a valve controlling the volume of air. The orifice used was sharp-edged and had a diameter of 3.1 in.

The hot-blast temperature measurements were taken by means of thermocouples both as it left the stove and at the bustle pipe. In calculating the efficiency, the bustle pipe temperature was used, allowing for radiation along the hot-blast main, and in determining the starting and ending points of the test, the temperature of the blast leaving the stove was relied upon. The cold-blast temperatures were sufficiently low so that they were obtained by the use of a thermometer.

In analyzing the blast-furnace gas the usual methods were employed for carbon dioxide and oxygen. However, hydrogen and carbon monoxide were determined very carefully by a slow combustion method, since the volume of blast-furnace gas passing to the stove was calculated on the basis of the change in the sum of these two caused by the air dilution.

In getting data for the carbon balance care was taken to extend it over a sufficient length of time to equalize any slight irregularities in operation. The possible error involved did not warrant the analysis of the scrap and limestone for carbon, and consequently figures for this given in Table I are estimates. The necessary gas analyses for the calculation of the carbon balance were obtained from the values given in Table I for the blast-furnace gas before diluting with air.

Moisture and dust determinations were made on the gas two or three times during the test.

Measurements made to determine the loss of heat due to cooling the hot-blast valve stem are not included in Table I, inasmuch as they consist merely in the measurement of the volume of water passing to and from the valve per unit time together with the change in temperature of this water.

In the determination of the so-called "skin"—i.e., surface—temperatures of the stove, use was made of an ordinary mercury thermometer immersed in mercury and insulated from the surrounding air by a small block of wood. This was so arranged as to be constantly movable over the surface of the stove.

In Table II the various computed results of importance are given.

#### DISCUSSION OF COMPUTED RESULTS

The air volume passing through the orifice per minute was obtained by the usual methods of calculation using 0.605 as a coefficient of discharge. The dilution of the gas by air was calculated from the change in sum of carbon monoxide and hydrogen, due to the addition of the air. The heating value of the gas was not determined calorimetrically, but was figured from the analysis of the gas.

From a knowledge of the carbon content of the stack gas and blast-furnace gas the volume of stack gas per volume of blast furnace gas was obtained.

In estimating all heat quantities involving changes in temperature of gases, the usual method was employed necessitating a knowledge of initial and final tempera-

TABLE II. COMPUTED RESULTS

Average air volume per min. through orifice at 37 deg. F. and 8 in. H <sub>2</sub> O, 433 cu.ft.
Per cent dilution of gas by air, 8.7.
Average gas volume per min. to stove at 32 deg. F. and 1 atm., 5,030 cu.ft.
Calorific value per cu.ft. of dry gas at 32 deg. F. and 1 atm., 94.3 B.t.u.
Total net time on gas, 809.5 min.
(Allowance made for small amount of gas from other furnaces.)
Volumes of stack gas per volume of blast-furnace gas (dry basis), 2.0.
Stack loss per min. above 62 deg. F. (average, dry basis), 73,200 B.t.u.
Pounds H <sub>2</sub> O per min. in blast-furnace gas (gas saturated), 4.0.
Pounds H <sub>2</sub> O per min. in air supplied for combustion, 1.25.
Heat loss per min. above 62 deg. F. due to moisture in air and gas, 860 B.t.u.
Heat required per min. to raise air for combustion from 37 to 62 deg. F., 3,110 B.t.u.
Per cent excess air used, 28.
Pounds H <sub>2</sub> O vapor formed per min. from combustion of hydrogen, 8.8.
Heat loss per min. above 62 deg. F. due to above H <sub>2</sub> O, 10,700 B.t.u.
Volume of air blast per min. from blowing engine displacement (dry basis 32 deg. F. and 1 atm.), 42,200 cu.ft.
Volume of air blast per min. from carbon balance (dry basis 32 deg. F. and 1 atm.), 41,500 cu.ft.
Time on air, 273.3 min.
Heat absorbed by blast per min. (dry basis), 863,000 B.t.u.
Pounds H <sub>2</sub> O in blast per min., 12.
Heat absorbed by H <sub>2</sub> O in blast per min., 5,970 B.t.u.
Radiation per min. along hot blast main from stove to bustle pipe, 5,250 B.t.u.
Heat required for cooling hot blast valve and valve stem per min. (stove on gas), 5,230 B.t.u.
Heat required for cooling hot blast, valve and valve stem per min. (stove on air), 19,400 B.t.u.
Convection coefficient for loss of heat from stove surface, 2.0 (B.t.u. per hr. per sq.ft. surface per deg. F. temperature difference).
Radiation coefficient for loss of heat from stove surface:
Combustion side, 1.3.
Flue side, 1.1.
Total radiation loss from stove surface per min., 34,400 B.t.u.

tures, analyses of gas and specific heats of the various gases over the temperature ranges involved.

An interesting comparison is shown between the volume of air delivered to the furnace as obtained from displacement figures on blowing engines and by the carbon balance method. It will be seen from the values given in Table II that the agreement was very close, the two figures checking within about 2.0 per cent. In estimating the slippage on the blowing engines, use was made of the results of a careful overall efficiency test of these engines.

The values used for heat loss by radiation were obtained by estimating the total coefficient of heat transfer from stove surface to air in terms of B.t.u. per hour per sq.ft. of surface exposed per deg. F. temperature difference. This total coefficient is the sum of two independent ones, that of radiation and that of convection. The latter was estimated, allowing as well as possible for wind velocity and other modifying influences. The radiation coefficient for black bodies was figured from a knowledge of the temperature difference between the exposed surface and surrounding air, and the total radiation loss then was calculated from a knowledge of the surface exposed, temperature difference between the surface and surrounding air, the time of the test, and total coefficient of heat transfer.

#### SUMMARY AND CONCLUSION

The efficiency figure of 62 per cent obtained in this test indicates a well-designed and well-operated stove, as this value compares very favorably with figures given in previously published reports<sup>1</sup> of tests made at other plants on stoves of the same type. It is realized that the comparatively short length of this test may tend to give a higher efficiency than would be shown by

<sup>1</sup>A. E. Maccoun, "Blast-Furnace Advancement," 1915 Yearbook American Iron and Steel Institute. A. N. Diehl, "Burning Blast-Furnace Gas," 1915 Yearbook American Iron and Steel Institute.

TABLE III. SUMMARY OF HEAT QUANTITIES

Efficiency and Heat Distribution:		
Heat Input:		B.t.u. Per Cent
Heating value in gas	384,000,000	100.0
Heat Output:		
Heating value in flue gas	59,900,000	15.6
Heating air for combustion	2,600,000	0.7
Uncondensed water from hydrogen combustion	8,700,000	2.3
Heat removed by air blast	238,000,000	62.0
Cooling water for valve	10,100,000	2.6
Radiation loss	39,000,000	10.1
Unaccounted for	25,700,000	6.7

tests run over a considerably longer time. In this work no attempt was made to determine the distribution of air or gas through the checkers, since it was not practicable to do this at this time. It is felt, however, that the stack loss of approximately 16 per cent indicates fairly uniform distribution through the checkers. Considerable information might be obtained from a comparison of figures obtained here with those resulting from previous tests<sup>2</sup> on other types of stoves such as center combustion and the three-pass or four-pass, but it is not within the scope of this report to attempt such a comparison.

While the figures for radiation loss included here are necessarily more liable to error than the others of Table III, since all factors influencing it cannot be definitely determined, yet even so it is felt that it is reliable to within about 2 per cent of the total heat input. Future work should be done on blast-furnace stoves along the line of the calculation of figures giving the transmission of heat from gas to brick work and brick to air. Figures such as these, if arranged in terms of fundamental units, have the possibility of ultimately being extremely helpful in the future design of hot-blast stoves. Especially useful would be a study of the relationships between such heat-transmission figures and varying velocities of gas or air through the stove.

The author desires to express his sincere appreciation of the hearty co-operation and extremely helpful advice given by various members of the operating, metallurgical and engineering departments of the Lackawanna Steel Co., as well as by his colleagues in the School of Chemical Engineering Practice.

<sup>2</sup>See J. E. Johnson, Jr., "Blast-Furnace Construction in America."

#### British Standard Leather-Measuring Regulations

On July 1, 1921, certain regulations promulgated by the British Government Board of Trade came into force, requiring every leather-measuring instrument to conform to an approved pattern verified and stamped by an inspector of weights and measures. This action has been taken in view of the increasing use of measuring instruments in the leather trade and must be complied with within a period of 12 months. Before the instrument can be passed by the inspector the templates—which are required to be provided—must be stamped at the National Physical Laboratory, and they must be subjected to a second stamping at the laboratory after the lapse of 12 months. This requirement is necessary because of the shrinkage to which templates are liable and until this has ceased the permanent area can not be ascertained.

The regulations provide for local standard templates to be kept by the local authorities, and based thereon all instruments will be verified by the inspectors at intervals of not less than six months. The full regulations have been issued under the title of "Weights and Measures (Leather Measurement) Regulations, 1921."



## The Engineer's Part in Industrial Safety\*

**A Plea for Industrial Safety Work in Which It Is Clearly Brought Out That Properly Conducted Accident Prevention Work Pays a Larger Return on Investment and Operating Cost Than Any Other Department of an Ordinary Industrial Plant**

By C. P. TOLMAN†

**I**N THE APPLICATION of engineering principles to safety the engineer is answering the same call of humanity to which engineers of all times have responded. There is probably no field of scientific industrial work which in any one plant calls for and can advantageously use a broader range of professional training and experience.

What is the magnitude of the problems with which we have to deal? I have before me some statistics prepared by Sidney J. Williams, secretary of the National Safety Council. We can read our answer in the following annual statement rendered and paid in full by the industries of our country in 1919:

Human lives.....	23,000	
Accidents, each causing four weeks' disability or more.....	575,000	
Accidents involving one day's disability.....	3,000,000	
Total equivalent working days lost.....	296,000,000	
At average wage of \$4 a day.....	\$1,184,000,000	
Incidental expense—medical, surgical, hospital, insurance, etc.....	\$161,000,000	
Total.....	\$1,345,000,000	
Credit—for the subsistence of 23,000 men who no longer need clothes, food, nor housing.....		\$331,000,000
Balance due.....	\$1,014,000,000	

You say perhaps it was an unusual year. Yes. In the previous year, 1918, more men were employed and the bill was 13 per cent larger.

Without further analysis we may safely agree that this waste of a billion dollars a year is great enough to demand attention. And our next question naturally is, "Can this waste be substantially reduced without prohibitive expense?" The answer is, "Yes; it has been done."

I have here totals from carefully recorded data in the files of the National Safety Council from eight widely known companies, members of the Council; in each case the accident record of one year is compared with the record of a previous year. The total number of men employed by these eight companies is 36,200. The reduction in accidents, measured by the difference in days lost per thousand hours worked, averages over 70 per cent. This is a most conservative figure, for in several cases effective accident prevention work was going on before the first of the two years compared. So we have part of our answer—it can be done.

### COST OF INDUSTRIAL SAFETY WORK

Now as to the rest: Is the cost prohibitive?

On the contrary, properly conducted accident prevention work pays a larger return on investment and operating cost than any other department of the ordinary industrial plant.

This is an astounding statement, but it is borne out by fact.

\*An address delivered before the joint meeting of the Cleveland Engineering Society and the Engineering Section of the National Safety Council, May 31, 1921.

†Chief Engineer and Chairman Manufacturing Committee, National Lead Co., and President National Safety Council.

A certain small company operating a coal mine with 100 men reduced its accident cost per ton 68 per cent. A large corporation tells us of a profit from its safety work of \$1,000,000 per year. These illustrations will serve as a general proof of the statement; they recite only what is to be found in the bookkeeper's balance. They tell us nothing of the incidental profits from better relations between men and management, and give no credit for the saving of human life and suffering. In the specific illustrations we shall consider only the cash profits. For with the assurance of definite profit the industrial manager need have no hesitation about undertaking organized safety work. He need fear no criticism from the owners; on the contrary, he is neglecting the owners' interest if he fails to establish the safety principle in his plant and give it that support, supervision and interest necessary for successful functioning.

Our immediate subject does not include that phase of safety work which has to do with the personal equation. Volumes have been written—available from the National Safety Council headquarters in Chicago—on the instruction of foremen and workmen, on methods of organizing shop safety committees, on medical supervision and first aid training, on the use of bulletin service, and on safe operating practices, both in general and applied to specific industries. All of this is essential to a successful safety program.

### PROBLEMS CONFRONTING THE ENGINEER IN HIS INDUSTRIAL SAFETY WORK

We are here considering the relation of the engineer as such to the material rather than the human side of industrial safety.

Usually the engineer finds for his problem a plant equipped and operating. He is required to make it as safe as possible with the following stipulations:

- (a) He must not interrupt operations.
- (b) He must do nothing which would decrease output or increase cost.
- (c) He must not make changes of a character or in a manner to cause labor trouble.
- (d) He must not make changes which will affect the character of the product.

Otherwise he has a free rein.

This seems to leave little chance for accomplishment. But hundreds of engineers are doing effective safety work under just such restrictions. The work is limited, of course, to the more common measures, such as guarding machines and transmissions, general betterment of ventilation, lighting and floor conditions, etc. It is well worth while, profitable to the industry, and calls for real ability.

The design of a gear guard is not beneath professional dignity. A gear guard which answers all require-

ments satisfactorily calls for skillful design. Among other requirements we have, for example, the following:

- (a) It must be securely attached.
- (b) It must be readily opened or removed.
- (c) It should be easier to close it than to leave it open.
- (d) It must not interfere with oiling or adjustment of the machine.
- (e) It should not drip oil or grease on the floor to make a slipping hazard.
- (f) It should be designed for economical manufacture.
- (g) The means for attaching and opening should be of a kind familiar or obvious to the average workman.
- (h) In so far as possible, it should permit inspection of gears without opening or removing.

Properly designed guards may save considerable in first cost, will save much in maintenance, and will remain in use. Improperly designed guards may not afford proper protection and, if awkward to replace, are usually left off, once they have been removed.

#### INDUSTRIAL SAFETY PLUS WASTE SAVING

Leaving the more obvious measures incidental to safeguarding machinery, let us consider the less obvious measures for safeguarding the immediate work of the operator. At once we are in a much more profitable field of work. Most of the profit in the earlier class comes through saving in cost through the prevention of accidents, whereas in the latter class, by bettering operation from the safety standpoint, we not only reduce accident cost, but if our work is properly done we invariably increase production or save waste. As an example of the latter, in the white lead industry portable dust collectors were developed and used for sanitary reasons. Purely out of curiosity the lead dust saved was weighed. The average of all factories showed a saving of lead amounting to a return of over 30 per cent on the investment.

#### INDUSTRIAL SAFETY PLUS INCREASE IN PRODUCTION

As an example of increased production, in the manufacture of steel drums, using toggle drawing presses, a factory was started about ten years ago with presses operating ten strokes a minute. At this rate the loss of fingers was alarming. The presses were therefore slowed down to seven strokes per minute. The accidents were reduced, but still were serious. The superintendent then devised and installed a method of operating the clutch by a solenoid magnet. The electric circuit led through two switches connected in series. These switches were arranged to open by springs and be closed by hand. One switch was located on each side of the press frame. To operate the press the workman had to use one hand on each switch. He could not get his hand or fingers in the press while it was operating. The presses were then speeded up to twelve strokes per minute, making an increase in production of 70 per cent with safe operation.

This is not an unusual case. Semi-automatic press feeds will, while making the operation safe, increase output from 10 to 100 per cent. Full automatic feeds will better this. Ejectors or kick-outs give similar results.

Lest we get the impression that results of this sort are confined to punch presses, suppose we consider another class of machinery infamous for mutilation of hands, the circular saw.

At the National Safety Council's congress in Mil-

waukee last year during a session of the Engineering Section it developed that 70 per cent of saw accidents originate in bad condition of the saw—dull, not properly set or not properly gummed. There were men present ranging from youth to rugged age, men who had lived with woodworking machinery. And they were unanimous on this point. They were then asked if saws and other woodworking machinery were kept in proper condition as compared with the average conditions, what increase in production would result. Again they agreed—at least 20 per cent. In other words, by keeping the saws in reasonable order, the average woodworking plant would eliminate the source of 70 per cent of saw accidents and make a net gain of 20 per cent in production with the same equipment, the same labor and less power.

#### SAFETY WORK IN MACHINE SHOPS

Once again that we may remember we are dealing with a broad general principle and not with any one class of machinery, let us consider the machine shop. Here we have the usual groups of accidents:

- (a) The kind which may befall any workman.
- (b) Selective accidents: (1) that select the careless, indifferent, or ignorant workman; (2) that select the best of the mechanics.

Aside from the labor turnover this last is a pretty serious proposition. The statement that there is a type of accident which selects your best men requires some proof. The best known example of this type happens when your machinist uses his hand as a brake on the rim of the face plate of his lathe. The man who does this is the man who wants to see his work progress. He is not content to stand idle while his lathe comes slowly to rest. He wants to get his micrometer on the work and see the result of the cut—to get the piece out when finished, and get in the next one. So he disobeys orders—he does just what you or I would do, he is interested in his job and he takes the chance.

This hazard can be wiped out. The corrective measure involves an important fundamental principle in safety work:

Make it easiest and most effective to do it the safe way.

In this case the thing to be done is to stop the lathe. The power must first be shut off. The remedy is obvious. Equip the lathe with a brake; if it is a belt-driven lathe, use a foot pedal which when pressed first shuts off the power and then applies the brake. The almost instantaneous effect of the powerful foot brake leaves no incentive to use the hand on the face plate. If the lathe is direct-motor-driven, use a controller designed for dynamic braking.

The International Harvester Co., at its Milwaukee shops, equipped the spinning lathes with foot brakes as just described. The accident hazard was eliminated and the increased production is paying an enormous return compared to the cost of this home-made attachment.

#### SAFETY WORK IN DESIGNING INDUSTRIAL PLANTS

Gratifying as are the results from careful analysis and treatment of hazards where found in a going plant, there is another broader fundamental method of treatment which is occasionally open to the engineer where a new plant is being built. Shall we digress a moment to make the principle clear by an illustration? The personal experience I am going to relate is one you



have all had. Recently I visited a plant for which an expensive addition was being planned. Upon going through the plant I found an unusual equipment of machinery specially designed for the work. The machines, although performing what would be considered difficult operations, were simple in that way which bespeaks the genius of the designer. But the arrangement of the machines was haphazard. Additions had been made from time to time and the original "flow sheet" was lost to view. Had the designer of the machines viewed his whole plant as one great machine, he would have done with it as he had done with the individual machines, and the additional building, machinery and labor would not be needed. This is the general principle of engineering revision as applied to safety: Regard the whole plant as a machine. Make the whole as well as each part function for safety. The production returns incidental to safe methods for the individual machine are multiplied again when the whole plant is co-ordinated on a safety basis.

#### SPECIFIC CASES FOR SAFETY DEVICES

Provision for clear aisles is a safety measure. It also facilitates transfer of materials and lowers production costs. Racks and bins properly placed reduce accidents from falling objects; they also save material from injury and facilitate production.

Correct lighting equipment and correct location of machines with respect to natural light prevents eye strain; waste from faulty manufacture is also saved, and production increased.

Grouping equipment involving special hazards or bad working conditions makes it possible to treat these conditions effectively and avoid exposure of other employees than those engaged in the particular work. For example, furnaces so grouped can be hooded to carry off heat and fumes; special cool air supply can be provided. The advantages of grouping apply also when chemicals are used or dusty operations are involved.

While some of these measures can be applied to a degree regardless of general plant arrangement, all of them can be applied much more effectively if it is feasible to treat the plant as a whole.

With the growth of an industry in volume it is usual to add more and more of the small capacity units which, although suitable as to capacity in the earlier days, have been outgrown, and too many units are needed to produce the output. It is engineering revision in respect to the custom of such an industry to redesign such equipment, increasing the capacity of the unit. The reduction of hazard is twofold when this is done—first, there are fewer men exposed; second, in redesigning, the equipment can always be made inherently safer. The reduction in manufacturing cost is obviously large. In the steel industry we have a striking example of just such revision.

#### HUMAN EQUATION IN SAFETY WORK

It is sometimes possible to make radical changes in the general process of manufacture, avoiding hazardous features and effecting large economies in operating cost. This is all work for the engineer, some phases of it calling for broader training and experience than others. To do any of it thoroughly and well we must include that factor which we have thus far omitted, the human equation. The engineer preparing for this work must become familiar with organized safety work and the practical data which have been patiently accumulated in

the course of such work. He must respond to the spirit of the safety movement, for words and data alone will not serve him.

#### SUMMARY

I have tried to establish two basic principles—first, properly conducted accident prevention work pays a larger return on investment and operating cost than any department of the ordinary industrial plant and, second, make it easiest and most effective to do it the safe way.

I have shown the opportunity for the engineer in this field of work. I do not mean that he is forthwith to christen himself safety engineer. On the contrary, he is not true to the ethics of his profession or to the interest of his client if, knowing the effectiveness of the safety viewpoint, he fails to make safety a part of his professional attitude toward all his work.

The safety movement needs the hearty co-operation of the engineer.

#### Antiseptic Treatment of Wood Pulp Prevents Mold and Decay\*

Tests show that by the addition of certain antiseptics to wood pulp it is possible to prevent to a large extent the decay and molding which now cause such serious losses in the pulp during storage. Several preservatives were found which kept groundwood pulp clean for a year under the most severe conditions which could be devised. The procedure adopted in the tests was, briefly, to inoculate the treated pulp with active mold spores and wood-destroying fungi and then to store it in warm, moist air in piles between laps of very rotten pulp.

In determining the relative suitability of the preservatives, account was taken of their effectiveness as antiseptics, poisonous properties, tendency to discolor the pulp, odor, solubility in cold water, and cheapness.

All things considered, sodium fluoride appeared to give the best results. A 5 per cent solution sprayed on the pulp at the rate of 80 lb. of dry salt to a ton of air-dry pulp, kept it practically clean for a year. A 3 per cent solution (48 lb. per ton) permitted only slight molding. This chemical is safe to handle, and produces no discoloration in the pulp.

Borax followed a close second to sodium fluoride. A 5 per cent solution (80 lb. per ton) held the pulp in good condition for 6 to 8 months. Borax is safe for workmen to handle and does not darken the pulp to an objectionable degree. Boracic acid was equal or superior to borax in effectiveness, but the greater cost throws it out of competition. Sodium dinitrophenolate in a  $\frac{1}{2}$  per cent concentration (2 lb. per ton) had an antiseptic efficiency equal to anything tried, but yellowed the pulp somewhat. Sodium dichromate gave less consistent results than the four chemicals mentioned, and the tendency toward browning was marked in concentrations of 2 or more per cent (32 lb. per ton). Sodium carbonate and bicarbonate, although they kept the pulp nearly free from infection for a year or more, browned and softened it too seriously for commercial use.

In the laboratory experiments, the antiseptics were sprayed with an ordinary garden sprayer on the pulp as it came from the wet machine. These experiments were followed by a mill trial in which the preservatives were applied at the press roll of the wet machine, with promising results. Improved methods of applications should make it possible to lower the concentrations and, consequently, the cost of treatment.

\*From U. S. Forest Products Laboratory.

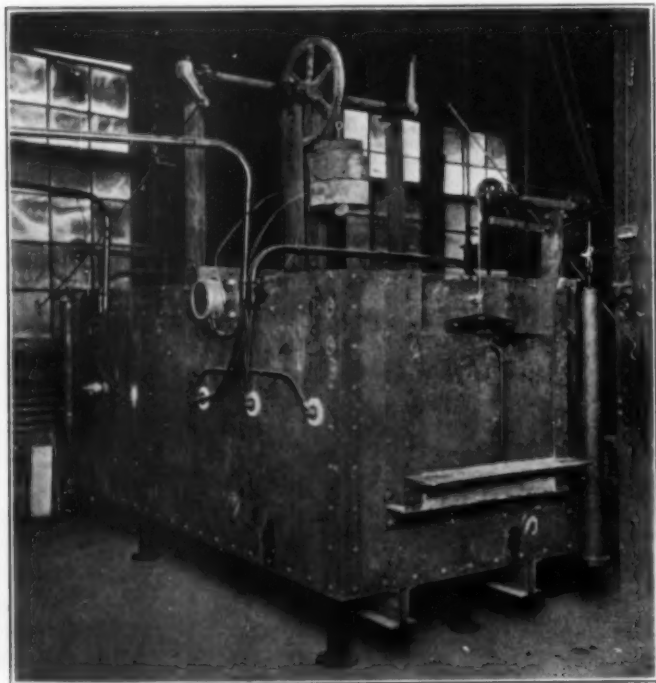
## Electric Vitreous Enamel Furnace

A TWO-COMPARTMENT electric furnace for baking vitreous enamel on resistance tubes has recently been installed at the Schenectady works of the General Electric Co.

The furnace is divided by a door which can be raised or lowered when a batch of tubes is to be transferred from one compartment to the other. These tubes consist of a grooved porcelain body, wound with resistance wire; the enamel is placed over this winding. The front compartment of the furnace is used as a preheater where the tubes are held at a temperature of 570 deg. F. for six minutes. This is necessary, because if the body of the tube is subjected to too high an initial temperature, it will crack. The connected load on this compartment is 9 kw. and the temperature is automatically controlled by means of a thermostat. When preheating is accomplished, the work is moved into the second or baking compartment by raising the door between the two compartments. In this compartment it is subjected to a temperature of 1,650 deg. F. for six minutes, emerging from it in a finished state. The connected load in the compartment is 24 kw. and the temperature is also automatically controlled by means of a thermostat.

The heating units on both chambers are arranged so as to give a very even heat distribution and, by using thermostats, an absolutely uniform temperature is obtained during the preheating and baking periods. This furnace also possesses the further advantage in that both operations—viz., preheating and baking—can be carried on at the same time on two different batches of work.

Each compartment will hold a tray containing thirty-six tubes which weigh about 27 lb.; the tray weighs 30 lb., so that there is a total load of 57 lb. in each compartment. The dimensions of the compartments are 48 in. long, 18 in. wide and 24 in. high and the overall dimensions of the furnace are 13 x 5 x 7 ft. The heating



ELECTRIC VITREOUS ENAMELING FURNACE WITH PRE-HEATING AND HIGH-TEMPERATURE COMPARTMENTS

equipments can be made for 230 volts direct current or 220 volts single phase alternating current.

This furnace has not only saved time and floor space but has improved the quality of the finished product and has reduced the percentage of defective tubes from 20 per cent to less than 1 per cent.

Some interesting comparisons have been obtained with this furnace and an oil-fired furnace which it replaced. Working on two different classes of material—viz., push buttons and resistance tubes—it was found that the kw.-hr. per lb. of push buttons was 1.87 and the cost per lb. was \$0.023. For resistance tubes, the kw.-hr. per lb. was 0.541 and the cost per lb. \$0.006. The cost per hour of operating the oil furnace was 72c., since it consumed 6 gal. of oil costing 12c. per gal. The cost over the same period with electric heat was 41c., or a saving of 31c. per hour in favor of the electric. It is estimated that production has also been increased approximately 50 per cent.

## A Convenient Formula for Diluting Solutions

BY E. J. McMILLAN\*

Where large volumes of standard solutions are prepared, much inconvenience is experienced in diluting such solutions to the desired strength on account of the inconvenience of directly measuring such large volumes.

A convenient and accurate determination of the amount of diluting required to bring any solution of unknown volume to desired strength is made as follows: Titrate the original solution against the standard. Add a known but insufficient amount of the diluent and titrate against the same amount of the standard.

Let  $C_1$  = number c.c. used in first titration.

$C_2$  = number c.c. used in second titration.

$C_3$  = number c.c. required when the solution is diluted to the desired strength.

$X$  = the original volume before diluting.

$N$  = the amount of diluent added.

$V$  = volume after diluting and making second titration.

$D$  = number c.c. required to be added to  $V$  to bring the solution to the desired strength.

$$\frac{X}{C_1} = \frac{X + N - C_1}{C_2} + \frac{C_1}{C_2}$$

$$X = \frac{NC_1 - C_1^2 + C_1C_2}{C_2 - C_1}$$

$$V = X + N - C_1 - C_2$$

$$V = \frac{NC_2}{C_2 - C_1} - C_2$$

$$D = \frac{VC_3}{C_2} - V$$

$$D = \frac{N(C_3 - C_2)}{C_2 - C_1} - (C_3 - C_2)$$

—  $(C_3 - C_2)$  can be omitted without appreciable loss of accuracy.

$$D \text{ then becomes } \frac{N(C_3 - C_2)}{C_2 - C_1}$$

This calculation can conveniently be carried out on a slide rule with sufficient accuracy.

\*Chemist, Cleveland Hardware Co., Cleveland, Ohio.



## New Synthetic Bearing Metal

A NEW bearing material called Genelite, recently developed in the research laboratory of the General Electric Co., has given remarkable results in a series of tests made to determine its performance, both when lubricated and self-lubricating.

It consists of a mechanical mixture of a high-grade "synthetic" bronze, and graphite, the latter amounting to about 40 per cent by volume of the whole mass. Since the material cannot be melted and poured into molds like ordinary metals, its formation into bearings is accomplished by a special process. It is made from the oxides of tin, lead and copper (mixed in the proportions to form a high-grade bronze) plus graphite, all the ingredients being in a finely divided state. Graphite is added in sufficient excess quantity to reduce the oxides to the metals and still leave the required content in the finished material. The oxides are partly reduced by heating the mixture, after which it is still in powdered form, but is then pressed as nearly as possible to the required shape in massive metal molds.

In the pressed form it is still too brittle to stand handling, so it is given a final heat-treatment which reduces and sinters the metals together into a homogeneous bronze, holding the graphite uniformly distributed throughout the mass. The evenness of this distribution is shown in Fig. 1, at 100 diameters. The white spots are the bronze, and the black ones the

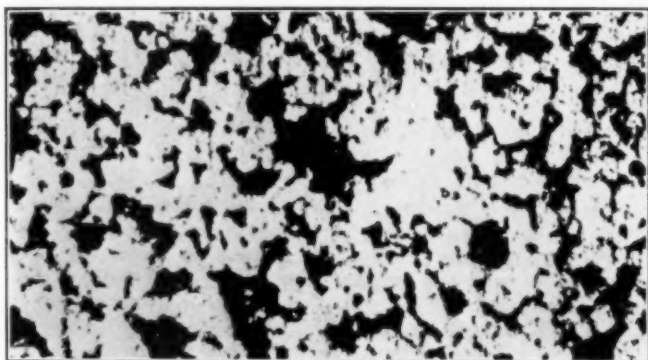


FIG. 1. MICROSTRUCTURE OF GENELITE.  $\times 100$

graphite. The baking fixes the graphite so securely within the mass that it cannot be separated or washed out, even if the metal is lubricated. Some of the various stages of manufacture are shown in Fig. 2, in which substance number 5 is the mixture after the preliminary bake, ready for pressing, 6 a bushing

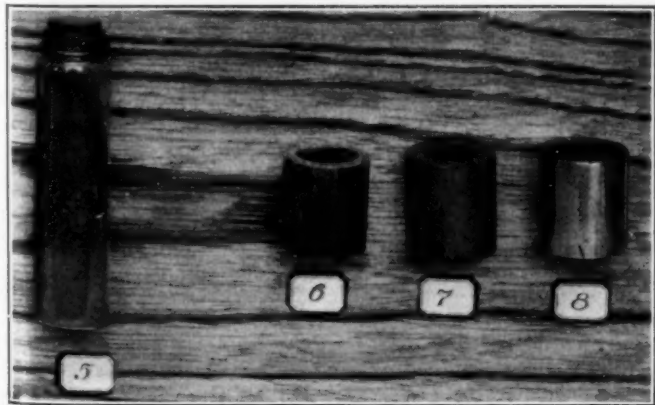


FIG. 2. VARIOUS STAGES IN THE MANUFACTURE OF GENELITE



FIG. 3. OIL SIPHONED FROM UPPER BEAKER BY CAPILLARITY THROUGH GENELITE AND WICKING

pressed from the powder, 7 a bushing after the final bake (or Genelite in the raw stock form) and 8 a finished piece. The material has the general appearance and body of bronze, but the characteristics are different. It does not machine readily by ordinary methods, but can easily be ground, which has been found to be the best method of handling it in production. Neither has it the physical characteristics of bronze, having very low tensile strength,

but being capable to withstand high compressive strains.

Another marked difference is its porosity, it being able to absorb as much as  $2\frac{1}{2}$  per cent by weight of oil. This feature is made use of in some of the high-speed applications where oil is applied to the outside of the bushing and carried to the bearing surface by capillary attraction. Fig. 3 is a piece of apparatus set up to show this feature of the material. Oil from the upper beaker is siphoned to the lower one through the rod of Genelite and the woolen wick by capillary attraction.

The tests have brought out another valuable characteristic, from the user's standpoint, in that a bearing made from this material never seizes or "freezes" as these expressions are commonly understood. The metal of the shaft and bearing never flow and weld together as a result of bearing friction. If the Genelite bearing sticks, owing to having been fitted too close, examination will show that no damage has been done, either to the bearing or the shaft, and they can be reassembled after the bearing has been ground down to proper size.

One of the principal uses of Genelite is on various parts of automobile engines where lubrication is either poor or neglected altogether owing to the inaccessibility of the bearing. Places where its self-lubricating properties render it valuable are on fan bushings, clutch centering bushings, throttle control bushings, etc. Places where lubrication is apt to be poor owing to dilution of the oil by uncombusted fuel products or other cause are also helped by the installation of Genelite bearings.

### Infringement of Permutit Patent

The broad patent of the Permutit Co. on zeolite water softeners was the subject of an infringement suit against the Hawley Foundry Co. and the Refinite Co., which was recently decided by Judge Hazel of the U. S. District Court at Buffalo, N. Y. The court recognized the priority of Gans' discovery of Permutit in 1906 and found that the apparatus used and manufactured by the defendant was an infringement on the Permutit Co.'s patented apparatus. An injunction was ordered against the defendants.

## Recent Chemical & Metallurgical Patents

### American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

**Electrolytic Cell.**—A horizontal diaphragm of asbestos superimposed upon a perforated iron cathode, which in turn forms the bottom of the cell, is the principal feature of an electrolytic cell patented by John M. Williams of Guthrie, Okla. In addition to its normal function, the diaphragm serves as a gasket to make a liquid-tight joint between the bottom and sides of the cell. The diaphragm is made preferably of sheet asbestos and is covered by a protecting layer of sand or finely ground glass. (1,376,495; May 3, 1921.)

**Bromine Extraction and Apparatus.**—When brine is treated electrolytically to liberate bromine, there are also produced considerable quantities of hydrogen and chlorine. If the succeeding steps in the extraction—viz., removing the bromine from the brine by blowing air through it, and finally absorbing the bromine from this air—are carried out in a closed circuit, there is danger of forming an explosive mixture. If the air, after removing the bromine, is allowed to escape and fresh air is drawn into the system, there may be a loss of heat. These objections are met by Herbert H. Dow in the following manner: The gas produced incidental to the electrolysis and not absorbed by the brine is withdrawn through a separate system containing a standard absorption tower to take up the bromine and chlorine. The brine is then conveyed to another system where the dissolved gases are removed by blowing out with air. This air after passing through the absorption towers necessary to relieve it of the bromine and chlorine is returned to the first blowing-out tower, thus maintaining a closed circuit throughout the system. (1,376,610; assigned to Dow Chemical Co., Midland, Mich., May 3, 1921.)

**Tempering Cam Shafts.**—An ingenious adaptation of electrical heating for hardening or tempering cam-shafts is described in a patent by John F. Wandersee of Highland Park, Mich. It is necessary in order to produce satisfactory cam-shafts that the cams be very hard to withstand constant wear, while the shafts must be relatively soft and tough. The hardening, which has formerly been accomplished by a long and laborious process of carbonizing and cyaniding, is brought about by placing the shafts into an ordinary electric welding machine in a manner such that only the cam itself is held between the two electrodes. Current is applied until the desired temperature is reached and the shaft is removed and quenched. (1,376,984; assigned to Ford Motor Co., of Detroit, Mich., May 3, 1921.)

**Clarifying and Decolorizing Oils.**—R. W. Mumford, of New York, has been granted a patent for a process of treating oils with a particular type of vegetable carbon, described as "an open-textured granular material having a porous structure representing approximately the original cellular structure of the material carbonized." This carbon is claimed to be more effective than fullers earth and the other decolorizing and clarifying agents commonly used for both vegetable and mineral oils. The patent covers different processes of applying the decolorant, one of which consists in utilizing electrically charged fields in order to facilitate the action of the decolorant. (1,377,021; assigned, by mesne assignment, to Darco Corp., of Wilmington, Del.; May 3, 1921.)

**Method for Producing Zinc Chloride.**—Paul Danckwardt has patented a process of preparing zinc chloride by utilizing as a source of his chlorine the residue obtained from the aluminum chloride method of oil distillation. The

residue, either as sludge or cake, is leached with water, the solution filtered and then treated with zinc ore in the proper proportion to precipitate all of the zinc. The aluminum separates out as the oxide and, if the ore used has been sufficiently pure, can be recovered as pure  $Al_2O_3$ —a valuable byproduct. The zinc chloride solution is evaporated and then heated to a high temperature for the production of the anhydrous salt. (1,378,219; assigned to the DANCKWARDT PROCESS CO., of Denver, Col.; May 17, 1921.)

**Granulating Converter Slag.**—In certain smelting operations, such as the production of copper matte, converter slag is sometimes poured into the ore-smelting furnace to aid in fluxing the charge. This method is not generally satisfactory, because the stream of molten slag does not mix properly with the ore charge. If, however, as the slag is fed into the furnace, a stream of steam under relatively high pressure is projected at right angles against the stream of falling slag, the latter is disintegrated and, in a granulated form, is spread over a large portion of the surface of the charge in the furnace. (1,378,223, SAMUEL RICHARD GARR, assignor to AMERICAN SMELTING & REFINING Co., of New York; May 17, 1921.)

**Recovery of Ammonia and Production of Barium Chloride.**—James H. MacMahon has devised a process for recovering both the ammonia and the chlorine present in the so-called feeder liquor of the ammonia-soda process. Former practice has been to free the volatile ammonia from the ammonium chloride and to pass this liquor into the lime still, where it is decomposed to form ammonia and calcium chloride. The calcium chloride represents a waste and moreover any free ammonia present in the waste liquor is lost. If, however, the black ash of crude barium sulphide is used instead of the lime, the barium chloride obtained is itself a valuable product or can be used for producing other barium salts. The ammonium sulphide formed, if decomposed with caustic soda, will yield marketable sodium sulphide. Modifications of the methods of carrying out these processes are described by which the different products can be obtained in various degrees of purity. (1,378,593 and 1,378,594; assigned to the MATHIESON ALKALI WORKS, INC., of Saltville, Va.; May 17, 1921.)

**Process of Making Calcium Bisulphite.**—A calcium bisulphite solution, which is rich in free sulphurous acid, is produced in a novel manner. Instead of causing a direct reaction between the sulphur dioxide and the milk of lime or of passing the free gas through a lime tower where it meets a counter-stream of water, George A. Richter, of Berlin, N. H., first acidulates water with sulphur dioxide in an absorbing tower, and then causes the acidulated water to react with lime in a separate reacting chamber. The product of this reaction may then be further acidulated to obtain the desired sulphur-dioxide content. (1,378,616; assigned to the BROWN Co., of Berlin, N. H.; May 17, 1921.) A second patent (1,378,617) provides for the preparation of a calcium-bisulphite cooking liquor by the use of a suspension of finely pulverized limestone instead of the milk of lime described in the previous patent.

**Process of Making Methanol From Methane.**—Methyl chloride is produced from methane by any suitable process and then in anhydrous alcoholic solution is converted into dimethyl ether by a process of heating with caustic soda under pressure. The dimethyl ether is subsequently hydrolyzed to methanol under high pressure. The latter reaction is accelerated by the presence of free mineral acid. The conversion of the methyl chloride is carried out in an iron receptacle containing ethyl alcohol and an excess of caustic soda under a pressure of about 20 atmospheres. The final hydrolysis usually proceeds very slowly unless fairly high temperatures are used. However, by the employment of certain accelerating agents, such for example as a 20 per cent solution of sulphuric acid, the reaction can be made to produce methanol on a commercial scale using a temperature of only 80 deg. C. The final reaction is carried out in tall, narrow iron cylinders tested for a pressure of 200 atmospheres. (1,379,362; E. H. RIESENFELD, of Freiburg, Germany, assignor, by mesne assignments, to the CHEMICAL FOUNDATION of New York; May 24, 1921.)



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## Current Events

### in the Chemical and Metallurgical Industries

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#### Object to Volstead Act Amendment

Determined objection is meeting even the modified amendment to the Volstead prohibition act. Senator Broussard, of Louisiana, in opposing the amendment, declared on the floor of the Senate that the bill should be known as the anti-prescription bill, rather than the anti-beer bill. His contention is that the Volstead act is intended to prohibit the beverage use of alcohol, and that no administrative officer of the Government should be vested with power which enables him to interfere with the valuable formulas of legitimate proprietary compounds in which alcohol is used and which gives federal officials a control over industrial alcohol which tends to discourage its manufacture.

"The proponents of this bill," declared Senator Broussard, "forget that alcohol is the universal solvent, one of the basic chemicals. They forget that if the manufacture of alcohol is impeded, many industries suffer. One result would be that this country would have to rely largely on imports of articles for whose manufacture alcohol is necessary. They do not conceive that alcohol is as essential to many industries in this country as pig iron is to the manufacture of steel." Senator Broussard also attacked the clause in the bill having to do with the refund of taxes when alcohol is stolen or lost before entering manufacture.

Senator Stanley, of Kentucky, expressed the opinion that the committee is without realization of the far-reaching effect of the alcohol-shipment clause of the bill, and he is not inclined to believe that any Senator is so ignorant of the legitimate use of alcohol for industrial purposes as not to want to encourage its manufacture, or that any Senator should want "to mulct in ruin the manufacture of industrial alcohol, when it could serve no legitimate purpose."

Senator Brandegee, of Connecticut, called the attention of the Senate to a communication he had from a large manufacturer of flavoring extracts and fruit syrups. "As a manufacturer of flavoring extracts and fruit syrups for soda fountains," said the telegram, "it is absolutely necessary to use non-beverage alcohol in flavoring extracts and less than half of one per cent in fruit syrups to cut the natural oil in the fruit. I have no objection to national prohibition, but this amendment, if passed, will disastrously affect business."

On the other hand, H. B. Thompson, the general counsel for the proprietary association, telegraphed Senator Willis that the Senate committee amendment is satisfactory to the members of his association.

#### Muscle Shoals on the Tapis Again

Announcement by the Secretary of Commerce that various chemical and power companies are considering the acquisition of the Muscle Shoals project has revived interest in this matter among members of Congress. Senator Underwood contends that the only way the public can secure the maximum benefit from the water power at Muscle Shoals will be by its operation by the Government. He continues to believe that the Government likewise should operate the nitrate plant. It is very evident, however, that a majority in the Senate favors the execution of any reasonable contract with a responsible private interest.

Just at this time, there is much opposition to further appropriations. Difficulties are anticipated in securing congressional approval for the \$28,000,000 which are required for the completion of the Wilson dam, even in view of the fact that the finished project could be leased. It is apparent that the majority in Congress prefers an arrangement whereby all additional expenditures should come from private sources.

The detailed proposal of Henry Ford is now being analyzed by the Chief of Engineers.

#### American Ceramic Society Meeting at St. Louis in 1922

The twenty-fourth annual meeting of the American Ceramic Society will be held in St. Louis, February 27 to March 2, 1922.

St. Louis is growing to greater importance as an industrial city every year. It is one of the largest centers for refractories and heavy clay products, while enameled ware, glass, and terra cotta are abundantly represented. A week of trips for the inspection of plants would be none too long.

The Hotel Statler will be the headquarters of the society and its facilities for the comfort of the meetings are unexcelled. Large rooms for divisional meetings, with a choice of ballrooms and banquet halls for the general sessions, will be available; while the luxury of the private rooms is too well-known to need description.

It will be noticed that the date is later than is customary. The reason for this is that the month of February is buyers' month in St. Louis, and the city is overcrowded without the additional influx of a national convention. The local men therefore urged that the date be put at the very end of the month, and the decision was made in accordance with this advice.

#### Dye Vote Surprises Congress

The opponents as well as the friends of the limited embargo prescribed for dyes in the Fordney tariff bill were surprised greatly at the action of the House in eliminating the dye schedule from the bill. At the time the matter first went to vote in the committee of the whole, there was some doubt as to the result, but with the apparently safe margin in favor of the embargo, indicated by the vote in the committee of the whole, there was little thought that the vote would be reversed in the House proper.

As a result of this unexpected action, communications reaching the finance committee of the Senate indicate that the entire chemical industry is aroused as never before, and that a determined effort is under way to secure the reinstatement in the Senate of the limited embargo.

It is very apparent that the important relationship between the dye industry and the national defense will play an important part in the contests certain to be waged in the Senate. General Amos A. Fries, head of the Chemical Warfare Service, will be one of the witnesses called by the Senate committee. He will reiterate his declaration to the House committee that he regards the plan of the Ways and Means committee for the handling of dye imports as absolutely necessary to the upbuilding of a type of dye industry essential to the national defense. He will point out to the Senate committee the close relationship between the dye industry and the manufacture of explosives and poisonous gases.

Now that it is absolutely apparent that the permanent tariff bill will not become a law prior to August 28, when the limited dye embargo expires, an effort will be made in the very near future to put through a bill extending the temporary embargo for another six months. If that embargo were allowed to lapse, it is declared that there are enough German dyes in American bonded warehouses to supply the American demand for two years.

#### New Ceramic School in Canada

The University of Saskatchewan, Saskatoon, Can., is perfecting plans for the establishment of a new ceramic department, to be the first such institution in Canada. W. G. Worcester, a graduate of the Ohio State University ceramic department, has been appointed professor at the new school.

### Manufacturing Chemists Make Plea for Protection

Scores of chemical products are being imported even now at prices which make American competition impossible. This is only the inception of this import movement of chemicals. Conditions abroad, particularly in Germany, have retarded that country's struggle for chemical supremacy, but from this time forward a systematic attack upon the American market is anticipated. This is one of the arguments used by Henry Howard, chairman of the executive committee of the Manufacturing Chemists' Association, at his appearance before the finance committee of the Senate. The general arguments presented by Mr. Howard were embodied in a brief which was filed with the committee, and later a number of members of the association called attention to specific commodities for which increased rates were needed.

### T.A.P.P.I. Notes—Plans for Fall Meeting

Among acquisitions to the membership list of the Technical Association of the Pulp and Paper Industry not previously reported are the following whose applications have been approved by the executive committee:

A. M. E. Johnstone, technical representative, Wallace & Tiernan Co., Newark, N. J.; L. J. List, engineer and sales manager, Samuel M. Langston Co., Camden, N. J.; Harold A. Morrison, sales engineer, Oliver Continuous Filter Co., 33 West Forty-second St., New York City; William J. Orchard, engineer and sales manager, Wallace & Tiernan Co., Newark, N. J.

### VOCATIONAL EDUCATION TEXTBOOKS

An appeal made by the committee on vocational education of the pulp and paper industry at the annual meeting of the association in April has met with generous response in some quarters. Following the receipt of letters from the committee stating the present situation with regard to funds for the continuance of the work, \$50 contributions have been received from each of the following: McDowell Paper Mills, Manayunk, Pa.; Hummel & Downing Co., Milwaukee, Wis.; Pittston Paper Corporation, Pittston, Pa.; Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.; Bardeen Paper Co., Otsego, Mich.; Tidewater Paper Mills Co., Brooklyn, N. Y.

At the annual meeting of the Technical Association, a contribution of \$500 was made by the Champion Fibre Co., Canton, N. C., and the New York & Pennsylvania Co. donated another \$500, which, with the contributions listed, make a total of \$1,300. The amount which it is hoped to raise in the United States to defray expenses of producing the complete set of vocational education textbooks on the manufacture of pulp and paper is \$7,500. It will be recalled that \$5,000 was subscribed by the Canadian Pulp and Paper Association as a body, the pro rata assessment on United States manufacturers being \$7,500. There is yet to be raised by contribution or otherwise the sum of \$6,200. The importance of continuing the work of the vocational education committee does not require to be emphasized in any way and it is hoped that firms who have delayed in responding to the appeal of the committee for funds will at once communicate with R. S. Kellogg, secretary of the committee, 342 Madison Ave., New York.

### TECHNICAL ASSOCIATION PAPERS

Series IV of *Technical Association Papers* has been issued and mailed to members. This makes a volume of 174 pages and covers. The volume contains verbatim reports of the various group meetings held during the annual convention of T.A.P.P.I., and all of the papers and their discussions are presented in full. The account of the banquet proceedings is especially interesting and entertaining. The after-dinner speeches are given in full and it is seldom that a more admirable mingling of grave and gay has been presented. Chemical warfare and the sources of the deadly gases used are described in a speech of great rhetorical ability by Prof. Bogert of Columbia University, while Ellwood Hendrick, president of the Chemists' Club, is represented with a whimsical discourse on odors which he announced as a "Homily on Olfactics." In his inimitable

fashion Dr. Hendrick spoke of odors in literature, the mnemonic associations of smell, and the function of smell in insects and animals. The relations of paper and electricity are touched upon by Calvert Townley, assistant to the president of the Westinghouse Electric & Manufacturing Co., who, however, did not stick closely to his text and told many stories. Paper's place in our daily life and the appalling situation which would develop if newspapers were abolished were the subject of an address by Arthur L. Dawe, secretary of the Canadian Pulp and Paper Association.

Technical education in general was the theme of a speech by Philip T. Dodge, president of the International Paper Co., whose talk is reported in full. Mr. Dodge made a plea for the interchange of technical knowledge and drew a picture of a project he had in mind for the establishment of a great central college or school for teaching the art of papermaking. It is a thoughtful speech well worth pondering. Series IV of *Technical Association Papers* sells for \$3 a copy.

### PLANS FOR JOINT FALL MEETING

Preliminary arrangements for the joint fall meeting of the Technical Association and the Superintendents Association are nearly completed. The heads of the local committees have been in conference with the secretary of the association at Washington and sub-committees appointed. The committee appointed by the Superintendents Association to co-operate with T.A.P.P.I. consists of the following members: Robert B. Wolf, 42 Broadway, New York City; Thomas F. Heberly, Schmidt & Ault Paper Co., York, Pa.; Nelson R. Davis, S. D. Warren Co., Cumberland Mills, Me.; James A. Ramsay, Dill & Collins Paper Co., Manayunk, Pa.; Leon K. Detwiller, Diamond State Fibre Co., Bridgeport, Pa.

Fred A. Curtis, chief of the Paper Section, U. S. Bureau of Standards, Washington, D. C., is chairman of the committee of arrangements for the fall meeting of T.A.P.P.I. and the Superintendents Association, assisted by Daniel A. Smith of the District of Columbia Paper Manufacturing Co. and Grellet N. Collins of Dill & Collins Paper Co., Philadelphia.

### Asks Hearing on Metric System Bill

An early hearing on his bill providing for the compulsory adoption of the metric system, after a period of ten years, has been asked by Senator Ladd of North Dakota. Senator LaFollette, the chairman of the committee on manufactures, states that he is disposed to grant the hearing but that he is dubious of securing the consent of any three members of his committee to act as a sub-committee to conduct the hearings. Senator LaFollette states that there is so much legislation at this time which appeals to him as being of greater importance that he cannot undertake the conduct of the hearings personally. He expresses the opinion that it will be difficult to find three members of the committee willing to take the time for metric system hearings during the consideration of the tariff and other matters of first importance.

Senator Ladd's plan is to conduct a short hearing at the earliest possible time in order that the outstanding arguments may be presented by each side, thus giving the public an opportunity to study the relative merits of these contentions. After the convening of the regular session in December, it is his desire to re-open the hearings and go into the question in a comprehensive way.

### Byproduct Coke Statistics

A monthly summary of byproduct coke production will be issued by the U. S. Geological Survey according to the new plan recently adopted. Reports are requested from every coke-oven operator as soon as possible after the first of each calendar month for the output of byproduct coke during the previous month. Summaries of these reports will be prepared and issued as a portion of the weekly coal report of the Survey appearing in the number next following the 15th of the month succeeding that to which the data apply.



### Federal Trade Commission Issues Order Against Royal Baking Powder Co.

Following inquiry, trial and final argument, the Federal Trade Commission on July 15, issued an order against the Royal Baking Powder Company to cease and desist from the sale or advertising for sale a phosphate baking powder under a label which simulates so closely as to be deceptive, a label long identified with a cream of tartar powder and from advertising price of the new powder as a reduction in price of the former product.

A competing concern complained against the Royal Baking Powder Company some months ago, charging unfair methods of competition. Testimony at trial of the case showed that the Royal Baking Powder Company in 1899 absorbed the company which manufactured and sold the well-known Dr. Price's cream baking powder, which had for its acid ingredient cream of tartar. At the trial it was shown that for a period of over sixty years prior to September, 1919, "Dr. Price's Cream Baking Powder" was marketed and advertised exclusively as cream of tartar baking powder, and that for at least thirty-five years the respondent and the Price Baking Powder Company carried on an extensive advertising campaign throughout the country to establish to consumers the superiority, especially from the point of view of healthfulness, of cream of tartar baking powder, and the inferiority of baking powders manufactured and sold by competitors which contained phosphate or alum or both as their acid ingredients. The latter competing powders were represented by the Royal Baking Powder Company in its advertising campaign to be unwholesome and deleterious.

It was further brought out in the testimony that in September, 1919, at a time when the price of cream of tartar was increasing the Royal Baking Powder Company after making certain alterations in its factory began the output of Dr. Price's baking powder substituting phosphate for cream of tartar as the acid ingredient of the commodity. It was shown also that coincidental with this change in the basic ingredients of the powder the Royal Baking Powder Company started a nation-wide campaign, advertising that the well-known Dr. Price's baking powder could now be bought by housewives for one half the price formerly charged.

This advertising campaign, it was shown by the testimony, misled the public into the belief that when it bought Dr. Price's baking powder it was buying the well-known cream of tartar brand for one half of what it formerly cost, when as a matter of fact it was buying a phosphate powder.

### Standardization of Petroleum Specifications

A number of changes in the specifications used by the Federal Government for the purchase of gasoline, kerosene, fuel and lubricating oils were proposed at an open meeting of the Technical Committee on Standardization of Petroleum Specifications held at the Interior Department Building, Washington, D. C., on July 12. N. A. C. Smith, of the Bureau of Mines and chairman of the committee, presided. Representatives of the different government departments and members of the technical staffs of the various refining companies were present. The several engineering societies constituting the Advisory Board were represented by the chairman of the board, Dr. T. G. Delbridge, of the American Society for Testing Materials and the American Petroleum Institute.

The new methods of testing various petroleum products, which have recently been approved by the American Society for Testing Materials, were discussed, and although the general sentiment of the meeting favored their adoption, it was decided that careful study should first be given to each method. The methods discussed included the following tests: corrosion; flash; distillation; sulphur; cloud and pour; saponification in place of fatty oil; water and sediment, precipitation; viscosity, and melting point.

Considerable discussion arose over the distillation range of motor gasoline. It was suggested that the present 90 per cent point should be raised slightly. On the other hand,

it was argued that the specification should be retained unchanged until such time as an entirely new grade of gasoline can be used. It was said that experimental work now in progress would probably afford more information as to the correct range for motor gasoline.

In view of the fact that the specification for fuel oil for Diesel engines, which had been intended to cover a very high grade of oil for submarines, has been criticised as being too stringent, a revision of the fuel oil specifications was proposed to show how several of the present grades can be used for Diesel and other oil engines. The raising of the permissible water and sediment from 1 to 2 per cent was advocated with the penalty attached for all water and sediment above one per cent. It was shown that testing the viscosity of fuel oils at 77 instead of 70 deg. F. would be in harmony with the work of the American Society for Testing Materials.

Other subjects discussed included the proper application of the saponification number of fatty oils, more definite color standards and a corrosion test for gasoline, and the need for further definiteness in the test for the emulsifying properties of lubricants.

At the close of the meeting Chairman Smith announced that he would tabulate the various suggestions made and would, within a short time, call a meeting of the Technical Committee to vote on the final form of the revisions, which would then be submitted to the Interdepartmental Committee for approval and publication.

The Committee on Standardization of Petroleum Specifications, frequently known as the Presidential Committee, was a war-time committee originally under the direction of the Fuel Administrator but later transferred to the Bureau of Mines. Bulletin 5 was its last official publication, and contained all of the committee's testing methods and specifications in their latest revised form. This war-time committee went out of existence on January 18 of this year, when the President authorized the Secretary of the Interior to form a new Interdepartmental Committee on Standardization of Petroleum Specifications.

The new committee met and organized on February 19 and adopted Bulletin 5 pending its revision. Each member of the committee appointed a technical representative, and these representatives were directed to form a Technical Committee to consider the revision of Bulletin 5 and to make recommendations in the matter to the Interdepartmental Committee. This plan was used successfully by the previous committee. The Technical Committee has met twice and has compiled a list of suggested changes and additions to Bulletin 5. Neither committee has yet voted on these proposals, but it is now planned to compile them in final shape and the Technical Committee will then decide what recommendations it will make to the Interdepartmental Committee.

The original committee tried to maintain as close contact as possible with the various industries involved in the manufacture and use of petroleum products. To make this contact even more effective the Interdepartmental Committee authorized the formation of an Advisory Board composed of representatives of the several engineering societies interested. This board met with the Technical Committee on May 4, and appointed Dr. T. G. Delbridge, representing the American Society for Testing Materials, as chairman. It is hoped that the Advisory Board will serve to bring to the attention of the committee such changes in the specifications as may become necessary from time to time, and that it will also be able to aid the committee by making available the technical knowledge of the refiners and of the consumers of petroleum products.

### Canadian Chicago Bridge & Iron Co. Changes Name

The Canadian Chicago Bridge & Iron Co., Ltd., of Bridgeburg, Ontario and Montreal, Quebec, has changed its corporate name to the Horton Steel Works, Ltd., in honor of the late Horace E. Horton, who founded the organization in the United States in 1865. The Canadian organization was first incorporated in 1913, the plant at Bridgeburg being constructed in that year.

## Chemical Exposition Notes

### DRIERS AND EVAPORATORS

The services of expert drying engineers from experimental drying laboratories will be at the disposal of any interested visitor at the Seventh National Exposition of Chemical Industries to be held in the Eighth Coast Artillery Armory, New York, Sept. 12 to 17. The discussion of all problems in connection with satisfaction and economy in drying products is urged by all exhibitors.

Exhibits on this subject will include a one-man machine that dries any material capable of being sprayed in three seconds, and to pass practically any mesh desired without scorching or burning, a vacuum chamber drier which dries sensitive materials which are subject to reaction, oxidation, discoloration, etc., at a high temperature, without any of these changes taking place, vacuum drum driers so constructed that every part is readily accessible, enabling the drier to be kept sanitary at all times, in fact every phase and condition of drying systems will be covered designed to eliminate all excess of consumption of steam, grinding costs, time, labor, and floor space.

Something new will be displayed in the nature of an evaporator, which will be featured by one exhibitor. This evaporator has been developed by long experience in the evaporator field. The heating tubes are neither horizontal nor vertical. They are installed in an angle position and are staggered. Steam enters the top chamber on left hand and descends through the tube toward the right. Any condensation formed falls to the bottom and goes out the pipe provided for this purpose. The steam which is not condensed rises and again descends through the tubes toward the left. This inclination of the tubes very materially increases the flow of the steam through the unit and consequently gives a very large capacity per sq. ft. of heating surface. Well directed and very violent circulation of the liquid being evaporated is one of the features of the machine, while a large expanding chamber above the heating surface has been provided.

How to turn waste liquors from a variety of chemical industries and convert noxious waste elements into a dry, compact, odorless and frequently valuable byproduct is one of the interesting subjects which will be discussed. In fact the exposition offers the technical and engineering service of the most experienced chemical engineers to visitors seeking a solution to such problems.

### Petrolia Helium Plant Shut Down

Orders have been issued to reduce the staff at the Government Helium Plant No. 3 at Petrolia, Texas, and to place the heavy machinery in standby condition for the present. These orders, issued by H. Foster Bain, director of the U. S. Bureau of Mines, have been concurred in by the U. S. Helium Board, composed of representatives of the Army, Navy and Bureau of Mines.

The extreme lack of funds necessary for the continuance of the plant and the desire to reduce to an absolute minimum the present expenditures of the Government have caused officials of the Bureau of Mines, which is immediately in charge for the Army and Navy, to feel that a stage has been reached where it will be better to work with a smaller unit while accumulating the data necessary for conversion into an economical operating plant, rather than to attempt steady operations with machinery planned primarily for experimental work. This plant was built in war time to test out the Jefferies-Norton process for separation of helium from natural gas and has since been operated intermittently on an experimental basis.

It is felt by the officials of the bureau that it is possible to place the Petrolia plant in a standby condition, since the large production plant at Forth Worth, operated by the Navy, is in operation. Both plants have been drawing on the same supply for gas and it will simplify the operations of the Lone Star Gas Company, which produces it, to have Plant 3 held in reserve while the Forth Worth plant is being brought up to full scale steady operation, since success is contingent upon a steady flow of gas of fairly uniform composition.

Plant No. 3, while undergoing trials, has produced helium

of 60 per cent purity and has made repeated runs of considerable duration, yielding gas of lower purity. While by re-processing, it is possible to bring up such gas to the standard for balloon use, this would increase the cost and it has been the expectation of the Bureau of Mines that first run gas of satisfactory purity could be obtained. As a war measure, it was considered wise to build on a sufficient scale so that the experimental plant could be transformed directly into an operating unit, but with the close of the war and the completion at Forth Worth of a production plant which, to a certain extent, meets present needs, it is more economical to conduct the experimental work on a smaller scale.

The purpose of continuing it is to provide ultimately a plant which shall furnish helium at a much lower cost than is possible by any known operative system. The importance of having a supply of non-combustible balloon gas in war time, and its utility in times of peace is so great that it is necessary that every means of reducing the cost be fully studied.

### American Foundrymen's Association Postpones Convention

From the date of organization to 1911 the conventions of the American Foundrymen's Association were held in May or June of each year. In 1912 it was found necessary to postpone the convention scheduled for June at Buffalo until late in September, due to delay in completing the building in which the exhibits were to be placed, and since that time the annual meetings have been held in the fall.

When the committee met this year to consider the place of the next meeting it was found that in none of the eight cities considered was it possible to find, during September or October, adequate hotel accommodations and exhibit facilities to properly care for such meetings as were held in 1919 and 1920.

Confronted with this situation and taking into consideration general industrial conditions, the committee adopted a resolution recommending to the board of directors that the convention be held in New York City, in October or November of this year, without exhibits. After due consideration it was decided to hold the next convention and exhibit in April or May, 1922, at a place to be selected by the convention and exhibits committee.

With the hotels disposed to reserve a larger percentage of their rooms for a convention in the spring than in the fall, and with the probability that better exhibition facilities can be secured in the spring of 1922, it is hoped that no difficulty will be experienced in making satisfactory arrangements for the next convention and exhibit, the place and date of which will be announced later.

### New Chemical and Oil Companies

During the month of June a total of 18 new chemical concerns were organized, with an authorized capital of \$50,000 or over, and aggregate capitalization of \$3,325,000. In a same month a year ago, the combined capitalization of companies formed in that month was \$41,476,000. This month has produced the lowest point yet recorded for 1921. For the first six months of the year, the total capital represented by new companies in the chemical field is \$65,625,000. Of this aggregate, January was the largest month, with an amount of \$22,295,000; the other months totaled: February, \$6,450,000; March, \$11,765,000; April, \$9,390,000; May, \$12,400,000, and June, as noted, \$3,325,000.

During the same month, a total of 65 oil companies was formed, with aggregate capitalization of \$52,620,000, each company being capitalized for \$50,000 or more. This is the lowest month of the present year and compares with June, 1920, with a total of 132 companies, and combined capitalization of \$161,275,000. During the first six months of the present year, a total of 545 companies in this line has been organized, with aggregate capitalization involving \$812,280,000. The largest month was April, representing \$227,470,000 in combined capitals of new companies. The other months were: January, \$163,480,000; February, \$136,935,000; March, \$148,850,000; May, \$112,925,000; and June, as noted, \$52,620,000.



### The Paper Industry in the Kalamazoo Valley District

There are 18 paper manufacturing companies in the Kalamazoo Valley district of Michigan, with stockholders in the different concerns totaling close to 2,000, the large majority of whom reside in this same section. Following unusually prosperous times, when large stock and cash dividends were declared, the industry is now passing through a period of curtailment. During the past 3 months the wages of employees have been reduced from 46 per cent to about 30 per cent at the different mills, and in this same period stockholders have sustained dividend losses ranging from 25 per cent upward.

### C.W.S. Needs \$4,000,000 Next Year

To carry on the work of the Chemical Warfare Service during the next fiscal year on a scale necessary to insure the proper development of that arm of the military service, Congress should appropriate not less than \$4,000,000 in the opinion of chemists who are familiar with the work of the service. This is exclusive of the expense which would be required for the production of masks or other equipment. It is declared that the work on war gases is at a stage of development which requires intensive application on a variety of chemical and mechanical problems, if practical use is to be made of the more recent developments in this work.

## Book Reviews

**IRON AND STEEL IN SWEDEN.** A compilation by *Alf Grabe*. Edited and Published under the control of and in co-operation with Jernkontoret. 183 pp., 7½ x 9½ in. New York: The Swedish Chamber of Commerce of the United States.

This well made book is frankly a piece of propaganda aimed at giving correct information regarding irons, steels and their major manufactures available for export. A list of producing firms is given under each class of material, together with post office and telegraph address, code, and export harbor. A good map is also included.

About one quarter of the hundred Swedish iron and steel firms are described in detail, and herein lies the main interest of the book to metallurgists. The equipment and plant of such well known companies as Uddeholm, Bofors, Sandriken, Osterberg, Avesta, and Hellefors are described. Particularly fascinating are the historical notes, nearly every one of the operations having its beginnings centuries back.

\* \* \*

**THE CHEMISTRY OF PLANT LIFE.** By *Roscoe W. Thatcher*. 268 pages. New York: McGraw-Hill Book Co., Inc. Price, \$3.

The author states in the preface that he had in mind a two-fold purpose in the preparation of the book which bears the above title.

First, it is hoped that it may serve as a reference book for collegiate students of plant science who are seeking a proper foundation on which to build a scientific knowledge of how plants grow.

Second, the purpose of the writer will not have been fully accomplished unless the book shall serve as a stimulus to further study in a fascinating field.

The chapter headings which follow give an idea of the scope of the work:

Introduction; Plant Nutrients; Organic Components of Plants; Photosynthesis; Carbohydrates; Gums, Pectins and Celluloses; Glucosides; Tannins; Pigments; Organic Acids, Acid Salts and Esters; Fats and Oils, Waxes and Lipoids; Essential Oils and Resins; The Vegetable Bases; Proteins; Enzymes; The Colloidal Conditions; The Physical Chemistry of Protoplasm; Hormones, Auximones, Vitamines, and Toxins; Adaptations; Index.

The book seems, to the reviewer, to be a chemistry of substances which occur in plants rather than a chemistry

of plant life. It contains in its various chapters excellent discussions of the chemical properties of various important plant substances such as sugars, glucosides, fats, proteins, pigments, etc. There is, however, relatively little on the living chemistry of these compounds. Each chapter closes with a discussion of the physiological uses of and the biological significance of the compounds discussed in that chapter. This discussion is necessarily limited in most cases by the meagreness of our knowledge of the chemistry of living processes. These chapter discussions in many cases suggest various avenues of investigation for the research student. In this Dean Thatcher has accomplished his second purpose admirably. The book should also go far toward accomplishing the first purpose since a knowledge of the laboratory chemistry of those compounds which occur in plants is important for an understanding of plant problems.

Dean Thatcher's book supplies a long-felt want since it is the first book of this kind from the pen of an American scientist who is a recognized authority in this field. "The Chemistry of Plant Life" should prove useful to a large number of students, either as a text or reference work. The book is well gotten up and is interestingly written. A few errors such as usually creep into a first edition were noted. For example, the formulas of some of the sugars and glucosides are incorrectly printed.

FRED W. UPSON.

## Personal

Dr. CARL L. ALSBERG, formerly chief of the Bureau of Chemistry, has left Washington, D. C., for Stanford University, where he will have the directorship of the food research institute of Leland Stanford University. Dr. Alsberg's successor has not yet been appointed.

W. H. BASSETT, technical superintendent of the American Iron Company, has been elected chairman, and G. C. Stone, metallurgist of the New Jersey Zinc Co., secretary, of a committee on zinc and zinc ores, recently organized by the American Society for Testing Materials, to work in co-operation with the American Zinc Institute.

ARTHUR M. COMEY, director of the Eastern Laboratory, E. I. duPont de Nemours Powder Co., has resigned and will reside in Cambridge, Mass. He expects to devote his time to writing.

C. D. DAVIES has been appointed managing editor of *Mechanical Engineering*, which is published by the American Society of Mechanical Engineers, succeeding the late L. G. French.

M. V. DISHER has become president of the Bertie Natural Gas Co., Ltd., Ridgway, Ont., succeeding John Young.

Dr. FEDERICO GIOLITTI is planning a brief business trip to America in a few months.

R. C. PURDY, consulting ceramic engineer, at Columbus, has been appointed chairman of the committee C-8 of the American Society for Testing Materials for the study of refractories.

OTTO W. SIEBERT, Gardner, Mass., for the past twenty-three years secretary and treasurer of the Bay State Metal Wheel Co., and the Children's Vehicle Corporation, both of East Templeton, Mass., has disposed of his interest in these companies to devote his entire time to the American Fiber Co., of which he is an officer and large stockholder.

E. C. WELBORN, 29 South La Salle St., Chicago, has opened offices as business and engineering counsel in the solution of financial, business and engineering problems. He was formerly identified with the Illinois Steel Co., the Allis-Chalmers Mfg. Co., the Standard Separator Co. and for the past two years has been vice-president of the Hanna Engineering Works, Chicago, in charge of engineering development, manufacturing and sales.

C. D. YOUNG was elected president of the American Society for Testing Materials at the recent annual meeting held at Asbury Park, N. J.

## Obituary

Major LOUIS A. FISCHER, chief of the Division of Weights and Measures of the Bureau of Standards, died at his home in Washington July 25, at the age of 57. Major Fischer had been in charge of that division of the Bureau's work since its foundation in 1910. Prior to that time, he served for many years in the old Weights and Measures office of the Coast and Geodetic Survey. Major Fischer obtained his title during the war, when he was commissioned to carry forward important work for the Ordnance Department. He was in immediate charge of the section of gage design.

EDWARD HARTNESS KIDDER, 82 years old, one of the founders of The Barrett Co., N. Y., died July 22.

## Current Market Reports

### The Chemical and Allied Industrial Markets

NEW YORK, July 29, 1921.

There was a slight improvement noted in the volume of chemical transactions during the past week, but no apparent snap to trading was visible. Quiet intervals are to be expected during this time of the year. Interests close to the pulse of business are convinced that the market is diverging from the course it seemed headed for and that it is gradually rounding itself into good shape. That the peak of depression has passed is the general belief of some of the largest manufacturers as well as dealers. The trend of chemical values has been downward since the beginning of the year, but prices in the more important commodities are showing more resistance at present. This condition is to be expected because there are no flagrant signs of forced selling while indications favor stability after a period of liquidation experienced for so many months. No one is looking for a sharp recovery in the general list although some items with more speculative value than others will eventually follow the road of least resistance. It has been the desire of producers to stabilize the values all around and it looks as though their efforts will be successful. Price changes for the week have not been noticeable. *Bichromate of soda* has held well around former levels and the market is being watched on account of advices regarding the tanneries. *Caustic soda* has been somewhat lower in the resale market while light *soda ash* has met with support at recently quoted prices. Contract prices on both of these latter items have not been altered in the open market. *Bleaching powder* has found buyers in the paper-making industry. *Prussiate of soda* eased off slightly under the competitive attitude of sellers. *Nitrite of soda* was also a shade easier. Domestic *oxalic acid* has been well sustained while small lots of imported material have moved at concessions. Some interests believe that *muriate of potash* is due for a rise while others do not anticipate any nearby change. *Sulphuric acid* is moving quietly at old figures. Leading producers of *copper sulphate* say that June sales to the agricultural trade exceeded all previous records. *Camphor* has ruled steady and a little firmer feeling was reported.

#### EXPORT OUTLOOK IMPROVING

According to those well posted in foreign affairs, the export outlook is gradually improving. Throughout the European continent, except Russia, conditions are steadily progressing, although the disordered state of public finances continues to be a heavy handicap to industry. German competition in the world market is favored by the position of the mark, but, on the other hand, continued inflation of the German currency, after inflation has practically ceased in

other countries, is serving to maintain German production costs, including labor, while they are declining in other important centers. Though the Russian situation imposes a severe detriment on European recovery, it is also to be remembered that Russia has been practically cut off from Europe for several years and business has become accustomed to do without Russia. In the European situation there are also indications of a steadying of political conditions and of a better attitude of the respective nations toward each other, which are of especial significance. A restoration of political stability must in a large measure precede Europe's economic rehabilitation. From the Far East we learn that conditions in India and China are clearly, even though only slightly, better, despite the position of silver and uncertain political factors in both countries. Improvement in Japan is plainly indicated by the improvement in the bank situation. The less developed countries, those chiefly dependent on an export market for raw materials, are at this time in the least satisfactory condition. Reviewing the world situation as a whole, for the first time since the armistice there is a sound basis for a hopeful outlook.

#### CHEMICALS

*Bichromate of potash* is finding a quiet outlook at 11½@11¾c. per lb., depending upon the quantity. Small resale lots have changed hands at 11½@12c. Odd lot sales of calcined *carbonate of potash*, 80-85 per cent, are reported at 5¼c. per lb. It is very possible that this price could be shaded on a firm offer for a round lot. The 90-95 per cent is obtainable at 6c. per lb. The inquiry is not very active and the movement is confined chiefly to small quantities. Imported *caustic potash*, 88-92 per cent, is moving quietly at 4¾c. per lb. and upward, according to the size of order. Some business in this material has been booked lately while soapmakers and dealers report the market quite steady at recently quoted figures. *Standard bichromate of soda* on spot is reported firm at 8c. per lb., with light trading reported at 8@8¼c. As previously stated, offerings are not heavy and it is doubtful if much material could be purchased without advancing quotations. Producers of *bicarbonate of soda* quote the market on a basis of 2¼c. per lb. in bbls. and 2½c. per lb. in kegs f.o.b. works. Sales of spot material have been reported by dealers at \$2.40@\$2.50 per 100 lb. in bbls. ex store. Resales of solid *caustic soda* have been reported at slightly lower prices although there is no sign of real weakness in the market. Producers quote the market firm at 3¼c. per lb., basis 60 per cent f.o.b. works and 5c. per 100 lb. higher for single carload lots. Dealers quote the market at \$3.85@\$3.90 per 100 lb. for standard goods either ex store or f.a.s. N. Y. Moderate miscellaneous inquiries are reaching the market but business in most quarters appears rather quiet.

Producers of *fluoride of soda* are reporting sales of this material at 12c. per lb. ex store. Prices in the open market range from 11½@13c. per lb. While rumors of odd lots of *nitrite of soda* have been heard at slight concessions, sellers were not inclined to quote under 7c. per lb. for spot material in the resale market. The general quotation was 7@7¼c. per lb., depending on quantity and seller. Imported *prussiate of soda* is quoted at 11½c. per lb. for shipment and spot quotations were heard at 11½@11¾c. per lb. The competitive attitude of sellers is responsible for the recent decline of values. Imported *sulphide of soda*, 60-62 per cent, fused, was offered at prices ranging from 4¼@5c. per lb. The broken variety is held at 5½@6c. per lb., depending on seller and quantity. Spot offerings did not appear to be unusually free, but it was stated that goods are expected within the next few days.

Prices on spot *citric acid* range from 44@45c. per lb., with most sellers not eager to shade 44½c. Small lots are attracting some attention and the movement is mostly of a jobbing character. Manufacturers of *hydrofluoric acid* are offering the 30 per cent test at 7c. per lb. in bbls. and report some business at this figure. The 48 per cent test is quoted nominally at 10c. per lb. and the 52 per cent at 11½c. per lb. Sales of *formaldehyde* are reported at prices ranging from 12½@13c. per lb., depending upon the seller. The demand is quiet and aside from the exchange of a few



moderate quantities the movement has been devoid of any special features. Dealers of *epsom salt* report sales of the technical variety at \$1.20@\$1.50 per 100 lb., according to the quantity. The U.S.P. variety is held at \$2.40@\$2.60 per 100 lb. in carload lots and up to 3c. per lb. in smaller quantities. American *oxalic acid* is quoted at 17½c. per lb. f.o.b. works and at various figures up to 19c. per lb. on spot, depending upon seller and quantity. Small lots of imported material are quoted at 17½@17¾c. per lb., with occasional odd lot sales down to 17½c. per lb. The inquiry for *sulphate of aluminum* was reported more active in some quarters and it was stated that the consuming trade was showing more interest. Sellers quoted the iron-free variety at 3@3½c. per lb. and the commercial at 2@2½c. per lb. Producers of *acetic acid* have slightly strengthened their views on the different grades. While it is possible that 2½c. might be done in a large way in the 28 per cent, commercial, first hands are not inclined to quote below 2½@3c. per lb. The 56 per cent test is quoted at 5@6c. and the glacial 99 per cent is moving quietly at prices from 10@10½c. per lb., according to seller.

The inquiry for *copper sulphate* for agricultural requirements still continues active and considerable business is being placed by leading producers. In one prominent selling quarter it was stated that June sales to farming sections were the best ever recorded. Textile mills are showing more interest and some business is being recorded. The increase in sales is quite large compared with a few months ago. Export inquiries are reaching the market but little actual business is being placed. Leading producers quote 5½c. per lb. for standard 99 per cent large crystals and up to 6c. per lb. for less than carload lots. Small crystals, 98-99 per cent, is quoted at 5½c. per lb. in carlots and ¼c. per lb. higher for smaller quantities.

#### COAL-TAR PRODUCTS

Leading producers of coal-tar products are firmly maintaining prices on their stocks. Some weak producers on the other hand are shading prices and holders of high priced resale goods are cutting prices. Surface conditions in the trade are rather spotty, but the undertone is surprisingly strong. One of the leading figures in the market states that in his opinion good business can be looked for at the beginning of the fall season and that in the meantime a steady improvement will be made in the volume of sales. Some producers report very favorable business over the past month, with consumers showing an increased tendency to buy ahead. On some products there undoubtedly will be further price reductions and liquidation of weak holdings may cause price flurries, but on the whole, consumers, by their recent steady buying are testifying to their faith in the stability of prices on many items. The export demand for *benzene*, particularly from England, continues strong, but supplies are limited and most of the orders remain unfilled. Domestic consumers have to be satisfied with future deliveries. Producers are firm at 27@33c. per gal. for the pure grade. *Naphthalene flakes* are easy with the demand rather light. Prime white flakes are quoted at 6½c. per lb. and off-colored can be had down to 4c. per lb. Balls are around 8@8½c. per lb. in the resale market. Producers of *toluene* quote lower prices than resellers, but it would be difficult to obtain a round lot from other than first hands. The demand is fairly strong, but the light supply keeps the price pegged at 28c. per gal. and up, depending on quantity. Some fair sized lots of *aniline oil* sold at 18c. per lb. Other sellers ask up to 21c. The demand is light, but some routine business is passing. Surplus stocks of *beta-naphthol* are making prices saggy and the low figure of 33c. per lb. could easily be shaded on real business. Inquiries were heard at prices below the above figure. Some sellers asked up to 36c. per lb., but buyers are uninterested at the high level. Lower prices on *paranitraniline* have stimulated buying to a fair extent. Quotations range from 75@85c. per lb. Light business passed in *para-phenylenediamine* at \$1.70 with quotations ranging up to \$1.80. More interest was displayed at the close of the week. Small lot business in *benzidine sulphate* passed at 75c. per lb. The base variety held at 85c., with some sellers asking up to 90c. per lb.

#### The Chicago Market

CHICAGO, Ill., July 29, 1921.

Developments of importance were lacking in the industrial chemical market during the past week. Dealers report a good volume of small orders but nothing in the way of large business was noted. As a rule prices were quite firm with little or no shading. Stocks are getting smaller and practically all distressed material has been absorbed.

*Caustic soda* is firm and quiet with supplies light. The solid 76 per cent is quoted at \$4@\$4.10 per 100 lb. and the ground or flake at \$4.65. *Soda ash* is moving in a very fair way and in some quarters stocks are getting low. The prevailing quotation was \$2.60 per 100 lb. in bbls., although it was possible to shade this price slightly in some directions for quantities. *Ammonium chloride* is quiet and unchanged as to price, supplies being readily available at 7½c. per lb. for the white granular. Spot stocks of *barium chloride* are offered freely at \$75@\$85 per ton according to the quantity. *Copper sulphate* is moving in a small way at 6½c. per lb. for less than car lots. The demand for *carbon tetrachloride* has dropped off somewhat but the price is firm at 11c. per lb. *Carbon bisulphide* is in better request and supplies are available at 6½@7c. per lb. *Formaldehyde* is dull and plentiful at 14c. per lb. in single bbl. lots. There is a fair movement of methanol 95 per cent at 75c. per gal. in drums. *Glycerine* is very quiet with plentiful supplies of the C.P. available at 14½c. per lb. There is a fair demand for *iron sulphate*, holders asking \$1.90 per 100 lb. for bbls.

A quiet market continues to be noted for *potassium bichromate* and the situation lacks new features of any kind. Buyers are interested only in small quantities and the price is unchanged at 14½@14¾c. per lb. *Sodium bichromate* is in the same position and supplies are available at 9@9½c. *Caustic potash* is quiet, dealers asking 6½@6¾c. per lb. for the 88-92 per cent material. A fair movement of *bicarbonate of soda* was noted at \$2.65 per 100 lb. *Hyposulphite of soda* continues to move in a small way to the photographic trade and dealers are asking \$4.05 per 100 lb. for the pea cryst. in bbls. *Zinc chloride* is moving in a small way and holders are asking 11@11½c. for spot goods.

There were no new developments in the acid markets during the past week, the prevailing tone being firm. The 28 per cent *acetic acid* continues to move fairly well and the price is unchanged at \$2.60 per 100 lb. for bbls. Glacial *acetic* is extremely quiet, some quarters reporting no sales. A wide range of prices are obtainable running from 8 to 11c. per lb. A brisk demand for *oxalic acid* was noted and the price is very firm at 18c. per lb. for bbls. The heavy acids are all quiet and unchanged in price. *Hydrochloric* is offered at 1½@2c. per lb. in carboys.

#### VEGETABLE OILS

*Linseed oil* is the item demanding the most attention in this branch of the trade. This material is quoted higher at 81c. per gal. for the raw and 83c. for the boiled. Dealers report a good movement to the paint trade and appear to be well satisfied.

#### NAVAL STORES

Business in the naval stores market continues good and all quarters report a satisfactory volume. *Turpentine* is moving in a very fair way at 66½c. per gal. Business on the *rosins* is better and the G grade is quoted today at \$5.50 per 280 lb. in car lots. *Rosin oils* are not moving so well and the spot price is unchanged at 45c. per gal. for material in coöperage.

#### The Iron and Steel Market

PITTSBURGH, July 29, 1921.

The turn in the tide as to the volume of demand upon the steel mills, only barely perceptible at the time of last report, has now become more clearly marked. Beginning in sheets the improvement has spread over bars, tubular goods and probably some other products. In no case is there any sweeping change, there being merely a gradual increase in the total volume of tonnage. Buying or specifying in large lots is conspicuously absent, engagements for moderate sized lots are few, and single carload orders and specifications are impressively numerous.

The totally wrong inference is drawn in some quarters that buying is being encouraged, business is being developed, by declining prices. Scrutiny of the business placed shows plainly that this is not the case. Steel prices are declining, but reduced prices are not made on the principle of encouraging buyers to buy. It might even be said that a mill does not reduce a price to bring the order to it, but rather to forestall its going elsewhere. That is, nearly every order or specification results from a determination of the buyer to buy, and buy at once. If there is negotiation, it is merely to determine where the order is to be placed, and at what particular price.

Practically all the increase in buying and specifying is attributable to further depletion of stocks, in the hands of jobbers and manufacturing consumers. Thus, instead of there being indicated any material increase in actual ultimate consumption of goods made from steel there is indicated rather a trend in demand upon the mills toward a rate in keeping with the present level of general industrial or commercial activity. For some time past the demand upon the mills has been subnormal in this relation.

#### PRICES DECLINING

While no formula can be devised to represent the rate at which steel prices have been or are declining, it may be said, very roughly speaking, that the average of all steel mill products has been going down in the past few weeks at the rate of something like a dollar per net ton per week. If precisely such a rate were maintained for a weighted average of the various commodities the average would be down to zero in about a year. The illustration may be fanciful, but it furnishes an idea of what has been occurring. Steel prices now, by a weighted average, are about \$15 per net ton above the ten-year pre-war average and about \$23 above the extreme low point, touched at the end of 1914. Considering the great increases in production costs there is no room left for an actual "break" in steel prices, but apart from that consideration, the market is too soft to break. The analogy between the market and a material is inexact only in that softness is a greater preventive of breakage in a market than in a material.

In last report reference was made to a recent trend in prices toward wider spreads between large lots and small lots. In the past week the trend has rather been the other way, of prices showing less variation according to the tonnage involved. What was the large lot price of two or three weeks ago may be the carload price now, but the large lot price has not declined as much as the carload price.

The independent market on bars, shapes and plates has tended to crystallize on prices of 1.75c. for bars and 1.85c. for shapes and plates, for carloads and moderate sized lots, with possibly slight concessions in some cases for large lots. As to Pittsburgh territory the Steel Corporation retains 1.90c. on bars and 2c. on shapes and plates as its regular prices, although it is possible concessions might be made. In territory removed from Pittsburgh the "Pittsburgh plus" system has disappeared very largely in substance, though the form may remain, by the necessity of meeting independent competition, particularly in Chicago territory.

The common market on sheets is 3.25c. for black and 4.25c. on galvanized, or \$5 a ton below the prices announced July 5, but the lower prices here named might be shaded in some cases.

#### OPERATIONS

There has been an increase in mill operations, on the whole, in the past fortnight, but the average rate of operation of the industry cannot be estimated closely enough to show the change. Steel production is probably at about 20 per cent of capacity. Rates are quite different in different lines. Sheets are being produced at perhaps 30 per cent of capacity, tubular goods coming next. Rail production is almost zero. The most conspicuous case of improvement is that of sheet mill operations by the Steel Corporation, which were a shade under 30 per cent week before last and about 36 per cent last week, while an average of about 40 per cent is likely to mark the present week.

#### General Chemicals

##### CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride.....	lb.	.....	\$0.40 - \$0.45
Acetone.....	lb.	\$0.12 - \$0.12 1/2	.13 - .13 1/2
Acid, acetic, 28 per cent.....	100 lbs.	2.75 - 3.00	3.25 - 3.50
Acetic, 56 per cent.....	100 lbs.	5.00 - 5.25	5.50 - 6.00
Acetic, glacial, 99 1/2 per cent, carboys.....	100 lbs.	10.00 - 10.25	10.50 - 10.75
Boric, crystals.....	lb.	.13 - .14	.14 - .15
Boric, powder.....	lb.	.15 - .15 1/2	.16 - .16 1/2
Citric.....	lb.	.....	.44 - .45
Hydrochloric.....	100 lb.	1.25 - 1.50	1.60 - 1.75
Hydrofluoric, 52 per cent.....	lb.	.11 - .11 1/2	.12 - .12 1/2
Lactic, 44 per cent tech.....	lb.	.10 - .11	.11 - .12
Lactic, 22 per cent tech.....	lb.	.04 - .05	.06 - .07
Molybdenic, C. P.....	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....	lb.	.....	.07 - .07 1/2
Nitric, 40 deg.....	lb.	.06 - .07	.07 - .07 1/2
Nitric, 42 deg.....	lb.	.07 - .07 1/2	.08 - .08 1/2
Oxalic, crystals.....	lb.	.17 - .18	.18 - .19
Phosphoric, 50 per cent solution.....	lb.	.13 - .14	.14 - .15
Picric.....	lb.	.20 - .25	.27 - .35
Pyrogallol, resublimed.....	lb.	.....	1.90 - 2.15
Sulphuric, 60 deg., tank cars.....	ton	.....	11.75 - 14.00
Sulphuric, 60 deg., drums.....	ton	.....	13.00 - 15.00
Sulphuric, 66 deg., tank cars.....	ton	18.00 - 20.00	.....
Sulphuric, 66 deg., drums.....	ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....	ton	.....	.....
Sulphuric, fuming, 20 per cent (oleum).....	ton	21.00 - 22.00	.....
Sulphuric, fuming, 20 per cent (oleum).....	ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum).....	ton	31.00 - 32.50	33.00 - 34.00
Tannic, U. S. P.....	lb.	.....	.90 - 1.00
Tannic (tech.).....	lb.	.45 - .48	.50 - .55
Tartaric, crystals.....	lb.	.....	.29 - .30
Tungstic, per lb. of WO.....	lb.	.....	1.30 - 1.40
Alcohol, Ethyl.....	gal.	.....	4.80 - 5.00
Alcohol, Methyl (see methanol).....	gal.	.....	.31 - .36
Alcohol, denatured, 188 proof.....	gal.	.....	.38 - .42
Alcohol, denatured, 190 proof.....	gal.	.....	.04 - .04 1/2
Alum, ammonia lump.....	lb.	.03 - .03 1/2	.04 - .04 1/2
Alum, potash lump.....	lb.	.10 - .11	.11 - .12
Alum, chrome lump.....	lb.	.02 - .02 1/2	.02 - .02 1/2
Aluminum sulphate, commercial.....	lb.	.03 - .03 1/2	.03 - .04
Aluminum sulphate, iron free.....	lb.	.07 - .07 1/2	.07 - .08
Aqua ammonia, 26 deg., drums (750 lb.).....	lb.	.30 - .32	.33 - .35
Ammonia, anhydrous, cyl. (100-150 lb.).....	lb.	.08 - .08 1/2	.09 - .10
Ammonium carbonate, powder.....	lb.	.....	.07 - .08
Ammonium chloride, granular (white).....	lb.	.06 - .06 1/2	.07 - .08
Ammonium chloride, granular (gray).....	lb.	.06 - .06 1/2	.07 - .07 1/2
Ammonium nitrate.....	100 lb.	2.20 - 2.25	2.30 - 2.40
Ammonium sulphate.....	100 lb.	.....	3.50 - 3.60
Amylacetate.....	gal.	.....	2.50 - 3.00
Amylacetate tech.....	gal.	.....	.07 - .08
Arsenic oxide, (white arsenic) powdered.....	lb.	.11 - .11 1/2	.12 - .13
Arsenic, sulphide, powdered (red arsenic).....	lb.	59.00 - 59.50	60.00 - 62.00
Barium chloride.....	lb.	.20 - .21	.22 - .23
Barium dioxide (peroxide).....	lb.	.07 - .07 1/2	.08 - .08 1/2
Barium nitrate.....	lb.	.04 - .04 1/2	.04 - .05
Barium sulphate (precip.) (blanc fixe).....	lb.	.....	.....
Bleaching powder (see calc. hypochlorite).....	lb.	.....	.....
Blue vitriol (see copper sulphate).....	lb.	.....	.....
Borax (see sodium borate).....	lb.	.....	.....
Bromine.....	lb.	.41 - .42	.43 - .45
Calcium acetate.....	100 lbs.	2.00 - 2.05	.....
Calcium carbide.....	lb.	.04 - .04 1/2	.05 - .05 1/2
Calcium chloride, fused lump.....	ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....	lb.	.01 - .02	.02 - .02 1/2
Calcium hypochlorite (bleach powder) (100 lb.).....	lb.	2.15 - 2.25	2.35 - 2.50
Calcium peroxide.....	lb.	.....	1.40 - 1.50
Calcium phosphate, tribasic.....	lb.	.....	.15 - .16
Camphor.....	lb.	.....	.75 - .78
Carbon bisulphide.....	lb.	.06 - .07	.07 - .08
Carbon tetrachloride, drums.....	lb.	.10 - .10 1/2	.11 - .12
Carbonyl chloride (phosgene).....	lb.	.....	.60 - .75
Caustic potash (see potassium hydroxide).....	lb.	.....	.....
Caustic soda (see sodium hydroxide).....	lb.	.....	.....
Chlorine, gas, liquid-cylinders (100 lb.).....	lb.	.08 - .09	.09 - .10
Chloroform.....	lb.	.....	.38 - .43
Cobalt oxide.....	lb.	.....	3.00 - 3.10
Copperas (see iron sulphate).....	lb.	.....	.....
Copper carbonate, green precipitate.....	lb.	.19 - .19 1/2	.20 - .21
Copper cyanide.....	lb.	.....	.50 - .62
Copper sulphate, crystals.....	lb.	.05 - .06	.06 - .06 1/2
Cream of tartar (see potassium bitartrate).....	lb.	.....	.....
Epsom salt (see magnesium sulphate).....	lb.	.....	.....
Ethyl Acetate Com. 85%.....	gal.	.....	1.00 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....	lb.	.....	.50 - .52
Formaldehyde, 40 per cent.....	lb.	.12 - .13	.13 - .13 1/2
Fusel oil, ref.....	gal.	.....	3.25 - 3.75
Fusel oil, crude.....	gal.	.....	1.75 - 2.00
Glauber's salt (see sodium sulphate).....	lb.	.....	.14 - .15
Glycerine, C. P. drums extra.....	lb.	.....	3.65 - 3.75
Iodine, resublimed.....	lb.	.....	.10 - .20
Iron oxide, red.....	lb.	.....	21.00 - 22.00
Iron sulphate (copperas).....	ton	19.60 - 20.00	.....
Lead acetate.....	lb.	.....	.11 - .13
Lead arsenate, paste.....	lb.	.09 - .09 1/2	.10 - .11
Lead nitrate.....	lb.	.....	.15 - .20
Litharge.....	lb.	.98 - .08 1/2	.08 - .09
Lithium carbonate.....	lb.	.....	1.30 - 1.40
Magnesium carbonate, technical.....	lb.	.09 - .09 1/2	.10 - .11
Magnesium sulphate, U. S. P.....	100 lb.	2.40 - 2.75	.....
Magnesium sulphate, technical.....	100 lb.	.....	1.20 - 1.60
Methanol, 95%.....	gal.	.....	.83 - .85
Methanol, 97%.....	gal.	.....	.86 - .88
Nickel salt, double.....	lb.	.....	.12 - .12 1/2
Nickel salt, single.....	lb.	.....	.14 - .14 1/2
Phosgene (see carbonyl chloride).....	lb.	.....	.47 - .50
Phosphorus, red.....	lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....	lb.	.....	.35 - .37
Potassium bichromate.....	lb.	.11 - .11 1/2	.12 - .12 1/2



		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	\$ .29 - \$ .30	\$ .29 - \$ .30
Potassium bromide, granular	lb.	.16 - .25	.16 - .25
Potassium carbonate, U. S. P.	lb.	.35 - .40	.45 - .50
Potassium carbonate, 80-85%	lb.	.05 - .05	.06 - .07
Potassium chlorate, crystals	lb.	.07 - .07	.08 - .12
Potassium cyanide	lb.	.26 - .28	.26 - .28
Potassium hydroxide (caustic potash)	lb.	.04 - .05	.05 - .05
Potassium muriate, 80% K.C.I.	ton	45.00 - 50.00	
Potassium iodide	lb.		2.75 - 3.00
Potassium nitrate	lb.	.09 - .09	.10 - .12
Potassium permanganate	lb.	.29 - .30	.31 - .32
Potassium prussiate, red	lb.	.28 - .29	.29 - .30
Potassium prussiate, yellow	lb.	.22 - .22	.23 - .23
Potassium sulphate (powdered)	per unit		1.35 - 1.35
Rochelle salts (see sodium potas tartrate)			
Salammoniac (see ammonium chloride)			
Salt soda (see sodium carbonate)			
Salt cake	ton		20.00 - 25.00
Silver cyanide	oz.		1.35 - 1.38
Silver nitrate	oz.		.40 - .41
Soda ash high	100 lb.	2.10 - 2.15	2.20 - 2.50
Soda ash, fense	100 lb.	2.35 - 2.40	2.45 - 2.70
Sodium acetate	lb.	.04 - .04	.04 - .05
Sodium bicarbonate	100 lb.	2.25 - 2.40	2.50 - 2.75
Sodium bichromate	lb.	.08 - .08	.08 - .09
Sodium bisulphate (nitre cake)	ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphate powdered, U.S.P.	lb.	.05 - .05	.05 - .06
Sodium borate (borax)	lb.	.06 - .06	.06 - .07
Sodium carbonate (as soda)	100 lb.	1.90 - 2.00	2.10 - 2.40
Sodium chloride	lb.	.07 - .07	.08 - .08
Sodium cyanide	lb.	.19 - .21	.22 - .30
Sodium fluoride	lb.	.11 - .12	.12 - .13
Sodium hydroxide (caustic soda)	100 lb.	3.85 - 3.90	4.00 - 4.50
Sodium hyposulphite	lb.		.03 - .03
Sodium nitrate	100 lb.	2.30 -	2.50 -
Sodium nitrite	lb.	.07 - .07	.07 - .08
Sodium peroxide, powdered	lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic	lb.	.04 - .04	.05 - .05
Sodium potassium tartrate (Rochelle salts)	lb.		.26 - .27
Sodium prussiate, yellow	lb.	.11 - .12	.12 - .12
Sodium silicate, solution (40 deg.)	100 lb.	1.00 - 1.15	1.25 - 1.40
Sodium silicate, solution (60 deg.)	lb.	.02 - .03	.03 - .03
Sodium sulphate crystals (Glauber's salt)	100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04 - .05	.05 - .06
Sodium sulphite, crystals	lb.	.03 - .04	.04 - .04
Strontium nitrate, powdered	lb.	.15 - .15	.16 - .17
Sulphur chloride, red	lb.	.07 - .07	.07 - .08
Sulphur, crude	ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders exu	lb.	.08 - .08	.09 - .10
Sulphur (sublimed), flour	100 lb.		2.25 - 3.10
Sulphur, roll (brim-tone)	100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent	lb.	.18 - .19	
Tin oxide	lb.		.40 - .42
Zinc carbonate, precipitate	lb.	.15 - .16	.16 - .17
Zinc chloride, gran.	lb.	.11 - .11	.11 - .12
Zinc cyanide	lb.	.45 - .49	.50 - .60
Zinc dust	lb.	.11 - .11	.11 - .12
Zinc oxide, XX	lb.	.07 - .07	.08 - .09
Zinc sulphate	100 lb.	3.00 - 3.25	3.30 - 3.50

## Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	\$1.10 - \$1.15
Alpha-naphthol, refined	lb.	1.25 - 1.30
Alpha-naphthylamine	lb.	.35 - .40
Aniline oil, drums extra	lb.	.18 - .21
Aniline salts	lb.	.25 - .28
Anthracene, 80% in drums (100 lb.)	lb.	.75 - 1.00
Benzaldehyde U.S.P.	lb.	1.00 - 1.25
Benidine, base	lb.	.85 - 1.00
Benidine sulphate	lb.	.75 - .85
Benzoic acid, U.S.P.	lb.	.60 - .65
Benzoate of soda, U.S.P.	lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 - .32
Benzene, 90% in drums (100 gal.)	gal.	.25 - .28
Benzyl chloride, 95-97% refined	lb.	.25 - .27
Benzyl chloride, tech	lb.	.20 - .23
Beta-naphthol benzoate	lb.	3.50 - 4.00
Beta-naphthol, sublimed	lb.	.70 - .75
Beta-naphthol, tech	lb.	.32 - .37
Beta-naphthylamine, sublimed	lb.	1.75 - 1.80
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)	lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums	gal.	.68 - .75
Cresylic acid, 75-97%, dark, in drums	gal.	.65 - .70
Cresylic acid, 50%, first quality, drums	gal.	.45 - .50
Dichlorobenzene	lb.	.06 - .09
Diethylaniline	lb.	1.20 - 1.25
Dimethylaniline	lb.	.38 - .48
Dinitrobenzene	lb.	.26 - .28
Dinitrochlorobenzene	lb.	.20 - .30
Dinitronaphthalene	lb.	.30 - .40
Dinitrophenol	lb.	.35 - .40
Dinitrotoluene	lb.	.27 - .30
Dip oil, 25%, car lots, in drums	gal.	.40 - .45
Diphenylamine	lb.	.60 - .65
H-acid	lb.	1.15 - 1.25
Meta-phenylenediamine	lb.	1.15 - 1.20
Monochlorobenzene	lb.	.12 - .14
Monoethylaniline	lb.	1.75 - 1.85
Naphthalene crushed, in bbls.	lb.	.05 - .08
Naphthalene, flake	lb.	.06 - .08
Naphthalene, balls	lb.	.08 - .09
Naphthionic acid, crude	lb.	.70 - .75
Nitrobenzene	lb.	.12 - .15
Nitro-naphthalene	lb.	.30 - .35
Nitro-toluene	lb.	.16 - .18
Ortho-amidophenol	lb.	3.10 - 3.20
Ortho-dichlor-benzene	lb.	.15 - .20
Ortho-nitro-phenol	lb.	.80 - .85
Ortho-nitro-toluene	lb.	.15 - .20
Ortho-toluidine	lb.	.20 - .25
Para-amidophenol, base	lb.	1.40 - 1.45
Para-amidophenol, HCl	lb.	1.60 - 1.75

Para-dichlorobenzene	lb.	.15 - .20
Paranitroaniline	lb.	.75 - .80
Para-nitrotoluene	lb.	.85 - .95
Para-phenylenediamine	lb.	1.70 - 1.95
Para-toluidine	lb.	1.25 - 1.40
Phthalic anhydride	lb.	.50 - .60
Phthalic acid, U. S. P., drums	lb.	.09 - .11
Pyridine	gal.	2.00 - 3.50
Resorcinol, technical	lb.	1.60 - 1.65
Resorcinol, pure	lb.	2.25 - 2.30
Salicylic acid, tech., in bbls.	lb.	.19 - .22
Salicylic acid, U. S. P.	lb.	.20 - .25
Salol	lb.	.80 - .85
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 - .16
Sulphanilic acid, crude	lb.	.30 - .35
Toluidine	lb.	1.25 - 1.35
Toluidine, mixed	lb.	.40 - .45
Toluene, in tank cars	gal.	.25 - .28
Toluene, in drums	gal.	.28 - .31
Xylidines, drums, 100 gal.	lb.	.40 - .45
Xylene, pure, in drums	gal.	.40 - .45
Xylene, pure, in tank cars	gal.	.45 - .45
Xylene, commercial, in drums, 100 gal.	gal.	.33 - .35
Xylene, commercial, in tank cars	gal.	.30 - .30

## Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	\$0.24 - \$0.25
Beeswax, refined, light	lb.	.27 - .28
Beeswax, white pure	lb.	.40 - .45
Carnauba, Flora	lb.	.58 - .60
Carnauba, No. 2, North Country	lb.	.25 - .26
Carnauba, No. 3, North Country	lb.	.13 - .14
Japan	lb.	.15 - .16
Montan, crude	lb.	.06 - .06
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03 - .03
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02 - .02
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 - .03
Paraffine waxes, refined, 125 m.p.	lb.	.03 - .03
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 - .04
Paraffine waxes, refined, 133-135 m.p.	lb.	.04 - .05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 - .06
Stearic acid, single pressed	lb.	.09 - .09
Stearic acid, double pressed	lb.	.09 - .09
Stearic acid, triple pressed	lb.	.10 - .10

## Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	\$5.10 -
Rosin E-I	280 lb.	5.20 - 5.45
Rosin K-N	280 lb.	5.70 - 6.75
Rosin W. G. W. W.	280 lb.	7.35 -
Wood rosin, bbl.	280 lb.	6.25 -
Spirits of turpentine	gal.	.59 -
Wood turpentine, steam dist	gal.	.57 -
Wood turpentine, dest. dist.	gal.	.55 -
Pine tar pitch, bbl.	200 lb.	
Tar, kiln burned, bbl. (500 lb.)	bbl.	7.00 - 11.50
Retort tar, bbl.	500 lb.	11.50 -
Rosin oil, first run	gal.	.35 -
Rosin oil, second run	gal.	.37 -
Rosin oil, third run	gal.	.41 -
Pine oil, steam dist., sp.gr. 0.930-0.940	gal.	1.80 -
Pine oil, pure, dest. dist.	gal.	1.50 -
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75 -
Pine tar, ref., thin, sp.gr. 1.080-1.060	gal.	.35 -
Turpentine, crude, sp.gr. 0.900-0.970	gal.	1.20 -
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990	gal.	.35 -
Pinewood creosote, ref.	gal.	.52 -

## Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	\$0.41 -
70-72 deg., steel bbls. (85 lb.)	gal.	.39 -
68-70 deg., steel bbls. (85 lb.)	gal.	.38 -
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30 -

## Crude Rubber

Para-Upriver fine	lb.	\$0.16 - .17
Upriver coarse	lb.	.09 - .09
Upriver cauchoball	lb.	.11 - .12
Plantation—First latex crepe	lb.	.14 - .14
Ribbed smoked sheets	lb.	.12 - .12
Brown crepe, thin, clean	lb.	.15 - .15
Amber crepe No. 1	lb.	.17 - .17

## Oils

## VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	\$0.09 - \$0.09
Castor oil, AA, in bbls.	lb.	.10 - .10
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.12 - .12
Cocanut oil, Ceylon grade, in bbls.	lb.	.09 - .10
Cocanut oil, Cochon grade, in bbls.	lb.	.10 - .11
Corn oil, crude, in bbls.	lb.	.08 - .08
Cottonseed oil, crude (f. o. b. mill)	lb.	.08 - .08
Cottonseed oil, summer yellow	lb.	.09 - .09
Cottonseed oil, winter yellow	lb.	.09 - .09
Linseed oil, raw, car lots (domestic)	gal.	.78 - .79
Linseed oil, raw, tank cars (domestic)	gal.	.72 - .73
Linseed oil, in 5-bbl lots (domestic)	gal.	.80 - .81

Olive oil, Denatured.....	gal.	\$1.30	—	\$1.40
Palm, Lagos.....	lb.	.06	—	.06
Palm, Niger.....	lb.	.05	—	.05
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07	—	.07
Peanut oil, refined, in bbls.....	lb.	.10	—	.10
Rapeseed oil, refined in bbls.....	gal.	.90	—	.92
Rapeseed oil, blown, in bbls.....	gal.	.94	—	.95
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07	—	.07
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06	—	.06

## FISH

Light pressed menhaden.....	gal.	\$0.42	—	....
Yellow bleached menhaden.....	gal.	.44	—	....
White bleached menhaden.....	gal.	.46	—	....
Blown menhaden.....	gal.	.50	—	....

## Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	....
Blanco fixe, dry.....	lb.	.04	—	.04
Blanco fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.06	—	.07
Chalk, domestic, extra light.....	lb.	.04	—	.05
Chalk, domestic, light.....	lb.	.04	—	.04
Chalk, domestic, heavy.....	lb.	.03	—	.04
Chalk, English, extra light.....	lb.	.04	—	.05
Chalk, English, light.....	lb.	.04	—	.05
Chalk, English, dense.....	lb.	.04	—	.04
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	25.00
China clay (kaolin) imported, lump.....	net ton	12.00	—	21.00
China clay (kaolin) imported, powdered.....	net ton	20.00	—	25.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Pa.....	net ton	18.00	—	....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07	—	.07
Graphite, Ceylon chip.....	lb.	.05	—	.05
Graphite, high grade amorphous crude.....	lb.	.02	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.68	—	.69
Shellac, orange superfine.....	lb.	.53	—	.54
Shellac, A. C. garnet.....	lb.	.46	—	.47
Shellac, T. N.....	lb.	.47	—	.48
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

## Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50—40.00
Carborundum refractory brick, 9-in.....	1,000	1250.00
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60
Chrome cement, 40-45% Cr <sub>2</sub> O <sub>3</sub> .....	net ton	30-32
Chrome cement, 40-45% Cr <sub>2</sub> O <sub>3</sub> , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33-35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36-40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30-35
Magnesite brick, 9-in. straight.....	net ton	70
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77
Magnesite brick, soaps and splits.....	net ton	98
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42-45
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	46-50
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35-38

## Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00
Ferrocchrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.14 — ....
Ferrocchrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15 — ....
Ferromanganese, 76-80% Mn, domestic.....	net ton	70.00 — ....
Ferromanganese, 76-80% Mn, English.....	net ton	70.00 — ....
Spiegeleisen, 18-22% Mn.....	net ton	26.00 — 27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 — ....
Ferrosilicon, 10-15%.....	net ton	40.00 — 42.00
Ferrosilicon, 50%.....	net ton	65.00 — 68.00
Ferrosilicon, 75%.....	net ton	135.00 — 138.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45 — .50
Ferrovanadium, 35-50% of V, per lb. of U content.....	lb.	6.00 — ....
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	4.25 — 4.50

## Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00 — \$10.00
Chrome ore, Calif. concentrates, 50% min. Cr <sub>2</sub> O <sub>3</sub> .....	unit	.30 — .33
Chrome ore, 50% Cr <sub>2</sub> O <sub>3</sub> , f.o.b. Atlantic seaboard.....	unit	.30 — .33
Coke, foundry, f.o.b. ovens.....	net ton	4.00 — 4.50
Coke, furnace, f.o.b. ovens.....	net ton	2.75 — 3.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00 — 15.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50 — ....
Fluorspar, standard, domestic washed gravel.....	net ton	20.00 — ....
Kentucky and Illinois mines.....	lb.	.01 — .01
Ilmenite, 52% TiO <sub>2</sub> , per lb. ore.....	unit	22 — 25
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	net ton	50.00 — 55.00
Molybdenite, 85% MoS <sub>2</sub> , per lb. of MoS <sub>2</sub> , N. Y.....	lb.	.55 — .60
Monazite, per unit of ThO <sub>2</sub> , c.i.f., Atlantic seaport.....	unit	30.00 — ....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12 — .12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.12 — .12
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11 — .12
Rutile, 95% TiO <sub>2</sub> per lb. ore.....	lb.	.15 — ....
Tungsten, scheelite, 60% WO <sub>3</sub> and over, per unit of WO <sub>3</sub> (nominal).....	unit	2.75 — 3.00
Tungsten, Wolframite, 60% WO <sub>3</sub> and over, per unit of WO <sub>3</sub> , N. Y. C.....	unit	3.00 — 3.25
Uranium ore (carnotite) per lb. of U <sub>3</sub> O <sub>8</sub> .....	lb.	1.50 — 2.50
Uranium oxide, 85% per lb. contained U <sub>3</sub> O <sub>8</sub> .....	lb.	2.25 — 2.50
Vanadium pentoxide, 99%.....	lb.	12.00 — 14.00
Vanadium ore, per lb. of V <sub>2</sub> O <sub>5</sub> contained.....	lb.	1.00 — ....
Zircon, washed, iron free.....	lb.	.03 — ....

## Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.00
Aluminum, 98 to 99 per cent.....	24.50 @ 25
Antimony, wholesale lots, Chinese and Japanese.....	41
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35.00
Monel metal, ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, S. rails.....	26.375
Lead, New York, spot.....	4.35-4.40
Lead, E. St. Louis, spot.....	4.20-4.25
Zinc, spot, New York.....	4.55
Zinc, spot, E. St. Louis.....	4.20

## OTHER METALS

Silver (commercial).....	oz.	\$0.61
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00 @ 75.00
Iridium.....	oz.	160.00 @ 180.00
Palladium.....	oz.	60.00-65.00
Mercury.....	75 lb.	43.50-45.00

## FINISHED METAL PRODUCTS

Warehouse Price  
Cents per Lb.

Copper sheets, hot rolled.....	20.50-20.75
Copper bottoms.....	28.00-28.25
Copper rods.....	19.25-20.00
High brass wire.....	16.75
High brass rods.....	13.75
Low brass wire.....	18.25
Low brass rods.....	18.25
Brazed brass tubing.....	27.00
Brazed bronze tubing.....	31.75
Seamless copper tubing.....	21.00
Seamless high brass tubing.....	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.00 @ 9.25	9.25	9.50
Copper, heavy and wire.....	8.25 @ 8.50	8.50	8.50
Copper, light and bottoms.....	7.00 @ 7.25	7.50	7.25
Lead, heavy.....	3.00 @ 3.25	3.25	3.25
Lead, ten.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.00 @ 4.25	4.50	5.00
Brass, light.....	3.00 @ 3.25	3.25	3.50
No. 1 yellow brass turnings.....	3.75 @ 4.00	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

## Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.23	\$3.00	\$3.00
S ft steel bars.....	2.18	2.80	2.80
Soft steel bar shapes.....	2.18	2.90	2.90
Soft steel bands.....	2.50	3.20	3.20
Plates, 1/2 to 1 in. thick.....	2.18	3.00	3.00

\*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn



# Industrial

Financial, Construction and Manufacturers' News

## Construction and Operation

### Arkansas

**LITTLE ROCK**—The Grandfield Refining Co., Kansas City, Mo., Garland Biffle, head of the company in charge, has plans under way for the establishment of a new branch oil refining plant at Little Rock, with initial capacity of about 5,000 bbl. Departments will be installed for the production of gasoline and naphtha. The new plant is estimated to cost about \$200,000 with equipment.

### California

**OXNARD**—The Sierra Oil & Refining Co. has plans under way for the erection of a new local refinery to handle crude petroleum from the Camarillo-Conejo fields, in which the company is operating.

### Delaware

**WILMINGTON**—The Atlas Powder Co., du Pont Bldg., has awarded a contract to the Austin Co., Bulletin Building, Philadelphia, Pa., for the erection of its proposed new 1-story experimental laboratory at Gray Street and Lancaster Avenue, to be 60x80-ft. The company has arranged for a bond issue of \$4,000,000 for general operations, financing, etc. W. J. Webster is president.

**WILMINGTON**—The Wilmington Sugar Refinery Co. has pile-driving and foundation work under way for the erection of its proposed new local sugar refining plant, to be 9-story, brick and steel, and estimated to cost in excess of \$2,500,000 with machinery. W. J. Wayte, Inc., Grand Central Terminal, New York, N. Y., is architect and engineer.

### Florida

**APOPKA**—The Florida Insecticide Co., is perfecting plans for the construction of a new local plant, 46x50 ft., for the manufacture of insecticides and chemical specialties. J. C. Grossenbacher is manager.

### Illinois

**CHICAGO**—The Waterway Paper Co., Kedzie Ave. and 32d St., has completed plans for the erection of a new 1-story plant on Kedzie Ave., 80x180 ft., estimated to cost about \$175,000, including power plant, 33x60 ft. Frank D. Chase, Inc., 645 North Michigan Ave., is architect and engineer.

**RAYVILLE**—The Hercules Powder Co., du Pont Bldg., Wilmington, Del., is arranging for a number of improvements in its local dynamite plant, now inactive. It is proposed to resume operations at the works early in the fall.

### Indiana

**ALEXANDRIA**—The Lippincott Glass Co. will make a number of improvements in its plant, including machinery repairs and betterments, during the remainder of the summer. The plant recently was closed down and will re-open early in the fall.

**EVANSVILLE**—The Graham Glass Co., is planning for the resumption of operations at its local plant at capacity early in September, concentrating on the production of bottles for beverages. Manufacture recently was curtailed with about 50 per cent of the regular working force.

### Louisiana

**SHREVEPORT**—The Gulf States Chemical Co., has acquired the plant and adjoining property of the National Glass Co. The new owner will enlarge the works and make a number of improvements in present buildings for the manufacture of chemical specialties. Equipment will be installed at an early date. W. H. Raplee is vice-president.

**NEW IBERIA**—Fire, July 20, destroyed the refining plant of the Morsham Sugar Co., with loss estimated at about \$250,000, including machinery and stock. It is reported that the plant will be rebuilt.

**SHREVEPORT**—The United States Window Glass Co., Morgantown, W. Va., is tak-

ing bids for the erection of its proposed new plant at Shreveport, to consist of a number of buildings, estimated to cost close to \$3,500,000 with machinery. The main glass works will be 1-story, 400x850 ft., with 3-story clay department, 80x140 ft. Other structures will include a power plant and box factory, the latter, 1-story, 100x200 ft. The DeVore Co., 908 Nicholas Bldg., Toledo, Ohio, is architect and engineer. Walter A. Jones is president. It is proposed to commence erection at an early date.

### Maryland

**CUMBERLAND**—A number of former employees of the Wellington Glass Co. are in negotiation with Franklin H. Ankeney, secretary of the local Chamber of Commerce, for the rebuilding of the Wellington plant, destroyed by fire more than a year ago. It is proposed to re-establish the works, giving employment to close to 300 operatives.

### Michigan

**DETROIT**—The Peninsular Paper Can Co., Detroit, is said to be planning for the establishment of a new plant at Monroe, Mich., for the manufacture of paper cans and other containers. It is proposed to inaugurate work at an early date, having the plant ready for service early in the fall. The company is arranging for a state charter with capital of \$500,000. R. P. Adams, sales manager of the Detroit Heating & Lighting Co., is president.

### Missouri

**OZARK**—The Bain Mining Co. is perfecting plans for the construction of a new concentrating plant, electrically operated, with capacity of about 250 tons, at its local ore properties; the company has a tract of about 600 acres of land for development. John Denton, Ozark, is vice-president and construction engineer. Eastern offices of the company are at 925 Market Street, Wilmington, Del.

### Nebraska

**ANTIOCH**—The Nebraska Potash Works has plans under way for the erection of new plant units to replace the portion of its plant recently destroyed by fire. The new buildings with equipment are estimated to cost about \$250,000.

### Nevada

**RENO**—The Candelaria Mines Co. has approved plans for the erection of a new reduction plant at its silver properties in the Lucky Hill district. The initial cyanide unit will have a capacity of close to 200 tons of ore daily, while the crushing plant will be equipped for a production of about 400 tons per day. Eastern offices of the company are at 43 Exchange Place, New York, N. Y.

### New Jersey

**TRENTON**—Milton Mirkens has acquired the former mill of the Ewing Rubber Co., Hilton Ave., for the establishment of a new plant for the manufacture of rubber goods. The structure will be remodeled at once and necessary machinery installed. The plant site totals 205x235 ft., providing space for future buildings.

**NEWARK**—Eric Steiner has leased the building in the rear of 52-54 Lafayette St., fronting on Maple Place, for the establishment of a new plant for the manufacture of colors, chemicals, etc., for the coloring of leather. Immediate possession will be taken and necessary equipment installed.

**LINDEN**—As soon as insurance has been adjusted, the Warner-Quinlan Asphalt Co., 79 Wall St., New York, N. Y., will commence the rebuilding of its plant at Linden, destroyed by fire July 18, with loss estimated at \$3,500,000, including equipment. In addition to the main manufacturing works, the loss included oil stills, oil tanks, asphalt tanks, gasoline tanks, machine shop and mechanical buildings, laboratory and power plant. Charles Almquist is superintendent.

**GLASSBORO**—The Owens Bottle Co. has started up one of the furnaces at its plant

at South Glassboro, following a curtailment of several weeks. Improvements and repairs are being made to the other furnaces at the plant, with plans to start up other units at an early date.

### New York

**ALBANY**—A new 1-story foundry for the production of bronze and brass castings will be erected at the plant of the Thatcher Propeller & Machine Co., Learned St. The structure, with new machine shop to be built, is estimated to cost about \$150,000. George Thatcher is president.

**BUFFALO**—The Iroquois Natural Gas Co., Iroquois Building, has increased its capital from \$10,000,000 to \$11,000,000, the proceeds to be used for plant extensions and improvements. Bert C. Oliphant is president.

**BROOKLYN**—The Doehler Die-Casting Co., Court and Huntington Sts., has commenced the construction of a new gas manufacturing plant at its works to cost about \$40,000. The plant will be for exclusive plant service and is being constructed owing to the prevailing high rate for gas. Operation is estimated at 40c. per 1,000 cu.ft.

**BUFFALO**—The Archer-Daniels Linseed Co., Buffalo River, near Hamburg Turnpike, is said to be planning for the rebuilding of the portion of its plant destroyed by fire July 10, with loss estimated at about \$50,000, including equipment.

### Ohio

**YOUNGSTOWN**—The Republic Rubber Corp. has resumed operations at its plant, following a suspension of several weeks, giving employment to about 700 operatives. Work will be conducted under the direction of H. C. Booth, receiver.

**CLEVELAND**—The Noble Refining Co., 706 Canal Road, has awarded a contract to the Camp Construction, Altamont Bldg., for the erection of its proposed new oil plant at East 99th St. and Elk Ave., estimated to cost about \$80,000. A power house will also be constructed.

### Oklahoma

**TULSA**—The Constantin Refining Co., operating local oil refineries, has arranged for a bond issue of \$4,000,000 for improvements, extensions, general operations, etc. E. Constantin, Sr., is president.

### Tennessee

**MOUNT PLEASANT**—The Phosphates Products Co., recently organized, is perfecting plans for the early erection of its proposed new local plant for the manufacture of fertilizer products. A number of plant departments will be installed, each for the purpose of manufacturing particular kinds of fertilizers.

### Texas

**HOUSTON**—The Southern Brass & Plating Co. is planning for the rebuilding of the portion of its plant recently destroyed by fire.

### West Virginia

**MORGANTOWN**—The South Penn Oil Co. is planning for extensions in its tankage department at a cost of about \$300,000. A number of new tanks, each with capacity of 74,000 bbl., will be installed.

**HUNTINGTON**—A new 1-story foundry, 50x120 ft., will be erected by the West Virginia Foundry & Stove Co., to be equipped for the manufacture of iron castings. It is proposed to double, approximately, the present plant output. Frank C. Boggess is manager.

### Wisconsin

**TOMAHAWK**—The Tomahawk Steel & Iron Co. will take bids early in August for the construction of a new 2- and 3-story plant, 100x180 ft., to replace its works recently destroyed by fire. The new plant is estimated to cost about \$75,000. William Bauman is manager.

**MILWAUKEE**—The Filer & Stowell Co., 219-45 Beecher St., manufacturer of machinery, will make improvements and extensions in its 1-story foundry to cost about \$16,000. Walter Read is president.

### Mexico

**DURANGO**—The Monterey Iron & Steel Co. is planning for the operation of its new iron ore properties at Iron Mountain, recently acquired, for raw material supply for its plant at Monterey, to be placed in active production at an early date.

## Capital Increases, etc.

THE VITREOUS ENAMELING & STAMPING Co., 306 Depot Place, New York, N. Y., has filed notice of increase in capital from \$300,000 to \$400,000.

THE SUMMIT VARNISH Co., Summit, Ill., has filed notice of increase in capital from \$50,000 to \$100,000.

THE SOUTHERN OIL CORP., Tulsa, Okla., manufacturer of petroleum products, has filed notice of increase in capital to \$3,000,000.

THE MONROE BINDER BOARD Co., Monroe, Mich., manufacturer of paper board products, has filed notice of dissolution under state laws.

THE AMERICAN STEEL PRODUCTS Co., Macomb, Ill., has filed notice of increase in capital from \$100,000 to \$210,000.

THE CHAMPLAIN BRICK Co., Mechanicsville, N. Y., manufacturer of brick and other burned clay products, has increased its capital from \$40,000 to \$100,000.

THE CUMBERLAND HYDRAULIC CEMENT Co., Cumberland, Md., has filed notice of increase in capital from \$200,000 to \$450,000.

THE UNITED STATES MICA MFG. Co., Chicago, Ill., has filed notice of increase in capital from \$10,000 to \$50,000.

THE SUNBEAM CHEMICAL Co., 2436 West Fifteenth Street, Chicago, Ill., manufacturer of soaps, etc., has filed a voluntary petition in bankruptcy.

THE INDUSTRIAL POTASH CORP., Salt Lake City, Utah, has filed notice of decrease in capital from \$30,000,000 to \$16,000,000.

THE SUNSET PAINT Co., Los Angeles, Cal., has filed notice of increase in capital from \$100,000 to \$150,000. H. A. Hendriksen is secretary.

## New Companies

THE SOUTH SANTA PAULA PETROLEUM Co., Los Angeles, Cal., has been incorporated with a capital of \$250,000 to manufacture petroleum products. The incorporators are Charles L. Horsey, Pioche, Nev.; W. H. Rand and Minor Moore, Washington Building, Los Angeles.

THE TIER CHEMICAL Co., 3920 Lake Park Ave., Chicago, Ill., has been chartered under state laws to manufacture chemicals and chemical byproducts. The incorporators are C. O. and P. H. Patter, and M. J. Farnbaker.

THE EASTERN METAL STAMPING CORP., Newark, N. J., has been incorporated with a capital of \$250,000 to manufacture metal stampings, etc. The incorporators are William G. Viall, Thomas W. Paterson and Frederick A. Slater. The company is represented by Karl Z. Kiefer, 810 Broad St.

THE E. R. NASH LEATHER Co., Boston, Mass., has been incorporated with a capital of \$25,000 to manufacture leather products. Edward P. Nash, Brookline, Mass., is president and treasurer.

THE POCOT OIL Co., Tonawanda, N. Y., has been incorporated with a capital of \$10,000 to manufacture refined oil products. The incorporators are F. G. Demaroe, F. J. Wallenberg and LeR. J. Tiebor. The company is represented by J. A. W. Simpson, Tonawanda.

THE NATIONAL ALLOYS Co., Detroit, Mich., has been incorporated with a capital of \$200,000 to manufacture aluminum, brass, bronze and other metal castings. The incorporators are Horace H. Lane, W. J. Reardon and John G. Collins, 2320 Dime Bank Bldg.

THE MARYLAND VEGETABLE OIL Co., Seventh Ave. and Sixteenth St., Baltimore, Md., has been incorporated with a capital of \$1,000,000 to manufacture vegetable oil products and byproducts. The incorporators are Enos S. Stockbridge, Roland H. Brady and J. A. Knoerr.

THE POSTAL PETROLEUM Co., Los Angeles, Cal., has been incorporated with a capital of \$750,000 to manufacture petroleum products. The incorporators are F. A. Andrew, E. G. Hurst and R. W. Street. Robert M. Fulton, Trust & Savings Bldg., represents the company.

THE SOUTHERN BOTTLE MFG. Co., Tampa, Fla., has been incorporated under state laws to manufacture bottles and other glass products. J. F. Jones, Tampa, is president; A. B. Jones, vice-president and treasurer; and R. L. Rundell, secretary.

THE OXFORD STEEL PRODUCTS Co., Boston, Mass., has been incorporated with a capital of \$300,000 to manufacture steel specialties. Clarence E. Dodge is president; and Maurice T. Viall, 155 Armington St., Cranston, R. I., treasurer.

THE PEABODY LEATHER Co., Camden, N. J., has been incorporated with a capital of \$100,000 to manufacture leather products. The incorporators are Eugene O. Peabody, D. Paul Brown and G. Lewis Mayor. The company is represented by the Corporations Co., 104 Market St.

THE C. F. BATTENFELD OIL Co., Detroit, Mich., has been incorporated with a capital of \$15,000 to manufacture greases, soaps, oil compounds, etc. The incorporators are J. R. Battenfeld, Jack Mourse and L. E. Thomason, Kansas City, Mo.

THE HUDSON GLASS Co., New York, N. Y., has been incorporated with a capital of \$9,000, to manufacture and deal in glass products. The incorporators are F. H. Sparks, R. W. Weed and L. Finkelstein. The company is represented by M. M. Fox, 201 Havemeyer St., Brooklyn, N. Y.

THE BELL CHEMICAL Co., 12 East 58th St., Chicago, Ill., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are Isadore Bell, Henry J. Tenhoope, and Elias Freudenheim.

THE EU-RE-KA SOAP Co., INC., Providence, R. I., has been incorporated with a capital of 480 shares of stock, no par value, to manufacture soaps and kindred products. The incorporators are Benjamin C. Emons, Thomas M. Webb, and Oscar H. Seavey, 276 Wickenden St.

THE GRANITE DISCOVERY OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$750,000, to manufacture petroleum products. The incorporators are George Dennison, S. J. Bowman, and L. L. Woods. The company is represented by Carnahan & Clark, 756 South Broadway.

THE BEL FAST ADHESIVE Co., Lyndonville, (Orleans Co.), N. Y., has been incorporated with a capital of \$25,000, to manufacture glue, paste and other adhesives. The incorporators are M. P. Barry, G. E. Lyman, and E. E. Belding, Lyndonville. The company is represented by W. S. Garber, attorney, Rochester, N. Y.

THE FAHEY LEATHER STAIN Co., Lynn, Mass., has been incorporated with a capital of \$25,000, to manufacture leather chemical products and affiliated specialties. Daniel J. Fahey is president; and John J. Fahey, 10 Blaisdell Terrace, treasurer.

THE BARRINGTON OIL Co., 1404 Harris Trust Bldg., Chicago, Ill., has been incorporated with a capital of \$1,000,000 to manufacture refined oil products. The incorporators are H. M. Cassidy, E. F. Brubaker, and R. O. Farrell.

THE TERRELL OIL & REFINING Co., Terrell, Tex., has been incorporated with a capital of \$250,000, to manufacture refined oil products. The incorporators are Robert L. Warren and W. P. Allen, Terrell.

THE APEX TIRE & RUBBER Co., Providence, R. I., has been incorporated with a capital of 250 shares of stock, no par value, to manufacture rubber products. The incorporators are John M. Franklin, Charles H. Sprague, and David W. Smith, 104 Franklin St.

THE BITUMINOUS COATINGS CORP., New York, N. Y., has been incorporated with a capital of \$5,000, to manufacture paints, varnishes, etc. The incorporators are W. B. Betzig, R. D. Kenmore and T. O'Callaghan, 115 Broadway.

THE ATLANTIC CARBONIC & CHEMICAL CORP., Chelsea, Mass., has been incorporated with a capital of \$125,000 to manufacture chemicals, chemical byproducts, etc. Phillips Rogers, 195 Winthrop Road, Brookline, Mass., is president and treasurer.

THE GENERAL REPRODUCTION Co., Philadelphia, Pa., has been incorporated with a capital of \$30,000 to manufacture sensitized paper and kindred products. C. R. Ringgard, 801 Vernon Road, is treasurer.

THE PETERSON SPRING Co., Detroit, Mich., has been incorporated with a capital of \$20,000 to manufacture steel springs, wire goods, etc. August Peterson, 4762 Townsend Avenue, is president.

THE CO-OPERATIVE OIL CORP., Long Beach, Cal., has been incorporated with a capital of \$350,000 to manufacture petroleum products. The incorporators are J. D. Hawk, J. S. Bradley and L. J. Keck, Long Beach. The company is represented by L. H. Wealton, 206 Marine Bank Bldg., Long Beach.

THE STERLING EXTRACT Co., INC., Wilkes-Barre, Pa., has been incorporated with a capital of \$10,000 to manufacture extracts, chemical compounds, etc. David Walkman, Wilkes-Barre, is treasurer.

THE MONROE OIL & REFINING Co., Fort Worth, Tex., has been incorporated with a capital of \$1,000,000 to manufacture refined oil products. The incorporators are V. S. Monroe, Fort Worth; and R. W. Perry, Polytechnic, Tex.

THE OHIO-KENTUCKY FLUORSPAR & LEAD CORP., White Castle, La., has been incorporated under Delaware laws with capital of \$1,000,000 to operate production plants for fluorspar, lead and kindred products. The incorporators are Thomas J. Clay, White Castle; C. P. Shaver, Thibodeaux, La.; and F. B. Moody, Smithland, Ky. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

## New Publications

### BOOKS

A DICTIONARY OF APPLIED CHEMISTRY. Vol. I, revised and enlarged edition. By Sir Edward Thorpe, assisted by eminent contributors. Pp. 752, illustrated. London and New York: Longmans, Green & Co., 1921. Price, \$20.

Volumes of this revised and enlarged edition of Thorpe's Dictionary will be issued at intervals during the next two years. Volume I is now ready and Volume II will probably appear during this summer.

An approximate idea of the amount of new material added can be gained from the fact that the new Volume I devotes 752 pages to subjects from Aal through Calcium, whereas this same range was covered in 614 pages in the previous edition. Six volumes will certainly be needed to complete the work and it is possible that a seventh will be required.

The work of revision has been carefully and thoroughly done and new articles have been prepared to cover recent developments, so that this work will maintain its position as the greatest contribution in English to the literature of applied chemistry.

TABLES OF REFRACTIVE INDICES, VOL. II—OILS, FATS AND WAXES. Compiled by R. Kanthack. Edited by J. N. Goldsmith, Ph.D., M.Sc., F.D.C. Pp. 295. London: Adam Hilger, Ltd., 1921. Price, £1, 5s.

This critical compilation of refractive indices of oils, fats and waxes is Volume II of a series from the research department of Adam Hilger, Ltd., Volume I on the refractive indices of essential oils having been published in 1918.

The present volume contains over 2,500 measurements on over 500 oils, fats and waxes, together with references to the original sources of information, so that it should prove invaluable to workers in this field.

## Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery rmory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del., Oct. 13 to 20.